PB-229 929

# SUMMARY OF WATER QUALITY POTOMAC RIVER BASIN IN MARYLAND

Public Health Service
Charlottesville, Virginia

October 1965

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 229 929

# SUMMARY OF WATER QUALITY
# POTOMAC RIVER BASIN
# IN MARYLAND

U.S. Department of the Interior
Federal Water Pollution Control Admin.
Library
Washington, D.C. 20242

Prepared By:
Chesapeake Bay-Susquehanna River Basins Project
Charlottesville, Virginia
October 1965

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

51

U.S. Department of the Interior
Federal Water Pollution Control Admin.
Library
Washington, D.C. 20242

# TABLE OF CONTENTS

Page

LIST OF TABLES . . . . . . . . . . . . . . . . . . . . . . . . . iii

LIST OF FIGURES . . . . . . . . . . . . . . . . . . . . . . . iv

INTRODUCTION . . . . . . . . . . . . . . . . . . . . . . . . . 1

WATER QUALITY CRITERIA . . . . . . . . . . . . . . . . . . . . 3

SOURCES OF WATER QUALITY DATA . . . . . . . . . . . . . . . . 5

WATER QUALITY PROBLEMS . . . . . . . . . . . . . . . . . . . . 11

- I. NORTH BRANCH POTOMAC RIVER . . . . . . . . . . . 13
- II. POTOMAC RIVER, SOUTH BRANCH TO CONOCOCHEAGUE CREEK . . . . . . . . . . . . . . 27
- III. POTOMAC RIVER, CONOCOCHEAGUE CREEK TO LITTLE FALLS . . . . . . . . . . . . . 33
- IV. POTOMAC RIVER ESTUARY . . . . . . . . . . . . . 51

SUMMARY OF WATER QUALITY IN THE POTOMAC RIVER BASIN IN MARYLAND . . . . . . . . . . . . . . . . 67

INDEX . . . . . . . . . . . . . . . . . . . . . . . . . . . . 69

APPENDICES . . . . . . . . . . . . . . . . . . . . . . . . . . 75

- I. Water Quality Criteria for the Potomac River in the Washington Metropolitan Area, by Interstate Commission on the Potomac River Basin . . . . . . . . . . . . . . I - 1
- II. Summary of Analyses of Water Quality Data for the North Branch Potomac River Obtained by the West Virginia Pulp and Paper Company . . . . . . . . . . . . . . . . . . II - 1
- III. Water Quality Data from a Special Study of the Upper Potomac River by the Public Health Service in 1965 . . . . . . . . III - 1

TABLE OF CONTENTS (Continued)

IV. Summary of Analyses of Water Quality Data for the Potomac River Basin from the Public Health Service Water Pollution Surveillance System . . . . . . . . . . . . . . IV - 1

V. Tabulation of Municipal and Industrial Waste Discharges in the Potomac River Basin of Maryland . . . . . . . . . . . . . . . V - 1

VI. Potential Fishery Classifications of Streams in the Potomac River Basin of Maryland, by U. S. Fish and Wildlife Service . . . . . . . . . . . . . . . . . . . . VI - 1

VII. River Mileages in the Potomac River Estuary: Maryland State Planning Department and Interstate Commission on the Potomac River Basin . . . . . . . . . . VII - 1

VIII. Figures . . . . . . . . . . . . . . . . . . . . . . VIII - 1

## LIST OF TABLES

| Table | | Follows Page |
|---|---|---|
| I. | MINIMUM WATER QUALITY CRITERIA FOR STREAMS IN THE POTOMAC RIVER BASIN by the Interstate Commission on the Potomac River Basin . . . . . . . . . . . | 4 |
| II. | CRITERIA FOR THE CLASSIFICATION OF MARYLAND STREAMS by the Maryland Department of Water Resources . . . . . | 4 |

## LIST OF FIGURES

(All Figures are Located in Appendix VIII)

1. Potomac Estuary - Turbidity vs. River Mile
2. Potomac Estuary - D. O. Concentrations, July 15 - September 15, 1960 - 1964
3. Minimum Dissolved Oxygen Concentrations at Three Sisters Island, River Mile 113.4
4. Minimum Dissolved Oxygen Concentrations at Roosevelt Island, River Mile 111.9
5. Minimum Dissolved Oxygen Concentrations at Giesboro Point, River Mile 107.4
6. Minimum Dissolved Oxygen Concentrations below D. C. Outfall, River Mile 105.1
7. Minimum Dissolved Oxygen Concentrations at Fort Foote, River Mile 101.7
8. Minimum Dissolved Oxygen Concentrations at Fort Washington, River Mile 97.8
9. Potomac Estuary - Coliform Concentrations, June - November, 1960 - 1964
10. Potomac Estuary - Coliform Concentrations, December - May, 1960 - 1964
11. Fish Kill of May 19, 1965

Maps of Municipal and Industrial Discharges

12. North Branch Potomac River
13. Potomac River - South Branch to Conococheague Creek
14. Potomac River - Conococheague Creek to Little Falls
15. Potomac River Estuary

# INTRODUCTION

In 1962 the Maryland State Planning Department initiated the Maryland Water Supply and Requirements Study. The purpose of the Study is to provide information to assist in planning for the development of the State's water resources to insure meeting future demands. This Study was divided into two principal phases: (1) determination of the existing characteristics of supply and demand, and (2) projections of demand on a multiple-use basis of ten-year intervals to the year 2020. The areal unit of investigations is by major drainage area and includes both surface and ground waters.

The Chesapeake Bay-Susquehanna River Basins Project, Public Health Service, agreed to prepare a report delineating the present surface water quality of the Potomac River Basin in Maryland. This summary, prepared in the format established by the State Planning Department, is to be included as one section of the Phase 1 report for the Potomac River Basin being prepared by the U. S. Geological Survey under a contract with the State Planning Department. The Geological Survey report will include information on drainage areas, hydrology, water uses, flow regulation, and the availability and quality of ground water.

The primary purpose of this summary is to present recent Potomac River Basin surface water quality data and to draw from these data general conclusions regarding the suitability of these surface waters for various uses within the framework of the water quality criteria promulgated by the Interstate Commission on the Potomac River Basin and the Maryland Department of Water Resources. Only the present quality of surface waters of the Potomac Basin within the State of Maryland and of surface waters from outside the State which have a significant effect on Maryland waters are included in this evaluation.

# WATER QUALITY CRITERIA

The Interstate Commission on the Potomac River Basin (INCOPOT) has developed minimum water quality criteria for each of several classes of water use (Table I) which are applicable to all tributary streams and to the main stem of the Potomac River upstream from the confluence of the Monocacy River. These criteria have not been officially assigned as quality objectives for the above specified streams or any specific portion thereof. They are used only to delineate concentrations of the various water quality indicators to serve as guides for evaluating the suitability of the quality of the surface waters for some present or expected use. However, the Commission has adopted specific water quality objectives and criteria for five sections of the Potomac River within the Washington Metropolitan Area from the confluence of the Monocacy River downstream to Hallowing Point (Appendix I).

In addition to these objectives and criteria, the States of Maryland and Virginia have established requirements to regulate sewage discharges for the section of the Potomac River watershed from Monocacy River to Little Falls. These requirements were adopted for the purpose of protection and preservation of water quality in this reach serving as the source of water supply for the District of Columbia and adjacent political subdivisions in Maryland and Virginia. The requirements established by these two States are sympathetic to the "no effluent concept" adopted in 1960 by the Washington Metropolitan Regional Conference (now Washington Metropolitan Council of Governments); upon completion of the Potomac River Interceptor, both existing and future discharges will be eliminated from this reach and will be handled by the Interceptor.

The Maryland Department of Water Resources (MDWR) employs water quality criteria for each of several classes of water use developed in 1949 by the former Water Pollution Control Commission (Table II). These criteria, which are applicable to all surface water streams within the State of Maryland, are used as guides similar to the INCOPOT criteria previously discussed. They have not been officially assigned as water quality objectives for the surface water streams within the State.

Based on a comparison of existing water quality with the criteria contained in Tables I and II, judgments were made by stream reaches as to which water use classes best describe the present quality of the Potomac River and its tributaries in Maryland. These judgments do not have any official standing and were made only to provide the basis for general conclusions regarding the suitability of these waters for various water uses.

In the five sections of the Potomac River within the Washington Metropolitan Area, the existing water quality was compared with the specific objectives for these segments as presented in Appendix I. As before, this was done to provide the basis for evaluating the suitability of these waters for the designated water uses.

## TABLE I - MINIMUM WATER QUALITY CRITERIA FOR STREAMS IN THE POTOMAC RIVER BASIN

by
Interstate Commission on the Potomac River Basin
(Approved 8 August 1946)

| | CLASS A | CLASS B | CLASS C | CLASS D |
|---|---|---|---|---|
| | Drinking Water (No treatment except Cholorination) | Bathing, Fish Life | Domestic Water Supplies (Before complete treatment) Industrial Process Water | General Sanitary Condition - to prevent nuisance |
| Coliform Bacteria | 0 - 50 | Mo. av. 50 - 500<br>Max. not over 1,000 | Mo. av. 500 - 5,000 | ------------------ |
| Color, ppm | 0 - 10 | 20 (desirable) | Amt. of color and turbidity allowed which can be removed by standard equipment and practices | ------------------ |
| Turbidity, ppm | 0 - 10 | 40 (desirable) | ------------------ | ------------------ |
| pH | 6.0 - 8.0 | 6.0 - 8.5 | 6.0 - 8.5 | 6.0 - 8.5 |
| 5-Day BOD, ppm | ---------------- | | | |
| Monthly av., ppm | ---------------- | 1.5 | 2.0 | 3.0 |
| Max. observation, ppm | ---------------- | 3.0 | 4.0 | 5.0 |
| Dissolved Oxygen, ppm | | | | |
| Monthly av., ppm | 7.5 | 6.5 | 6.5 | 4.0 |
| Min. observation, ppm | 6.5 | 5.0 | 5.0 | Min. daily ave. 3.0<br>Absolute min. 2.0 |
| Other Conditions | No toxic substances, oil, tars, or free acid at any time. No floating solids or debris, except from natural sources. No taste - or odor-producing substances | Same as A | Same as A | No toxic substances. oil, tars, or free acid at any time. No floating solids or debris, except from natural sources. Slight localized sludge deposits, if unpreventable, allowed. No offensive odors. |

NOTE: These criteria are to be used only in conjunction with a sanitary survey as a guide in determining the minimum water quality for the various classes of water use listed. It is intended that these criteria should apply to conditions which are expected to prevail for the major part of the time.

## LIST OF FIGURES (Continued)

Maps of Present Water Quality

16. Based on "INCOPOT" Criteria

17. Based on "MDWR" Criteria

## TABLE II - CRITERIA FOR THE CLASSIFICATION OF MARYLAND STREAMS

by
Maryland Department of Water Resources

| DETERMINATIONS | | CLASS AA | CLASS A | CLASS B | CLASS C |
|---|---|---|---|---|---|
| NAME Zoning (Symbol) | Period Covered | Excellent source of water supply; excellent fish habitat, recreational and industrial water | Good source of water supply; good fish habitat, recreational and industrial water | Serve as source of water supply with complete and auxiliary treatment, poor fish habitat, recreational and industrial water. | Unsatisfactory source of water supply; unsuitable as fish habitat and recreational water |
| Most probable number Coliform Bacteria per 100 ml--- (C) | Average any month | Not over 100 | Not over 2,000 | Not over 10,000 | Over 10,000 |
| Dissolved oxygen p.p.m.----- (D) | Average any month<br>Minimum any day | Not less than 7.5<br>Not less than 6.5 | Not less than 6.0<br>Not less than 5.0 | Not less than 4.0<br>Not less than 3.0 | Less than 4.0<br>Less than 3.0 |
| 5-Day B.O.D. at $20^{o}$C.p.p.m.- (B) | Average any month<br>Maximum any day | Not over 0.75<br>Not over 1.0 | Not over 2.5<br>Not over 3.5 | Not over 6.0<br>Not over 7.0 | Over 6.0<br>Over 7.0 |
| pH-------($O_1$)--------------- | Average any month | 6.2-8.4 | 5.8-9.0 | Between 3.8-5.8 or 9.0-10.5 | Less than 3.8 or over 10.5 |
| Fluorides p.p.m.------------ ($O_2$) | Maximum | Not over 1.0 | Not over 1.0 | Not over 1.0 | Over 1.0 |
| Chlorides p.p.m.------------ ($O_3$) | Maximum any day | Not over 50 | Not over 250 | Not over 500 | Over 500 |
| Phenolic Compounds p.p.b.--- ($O_4$) | Maximum | None | Not over 5.0 | Not over 25 | Over 25 |
| Iron and Manganese p.p.m.--- ($O_5$) | Maximum | Not over 0.3 | Not over 1.0 | Not over 15 | Over 15 |
| Color p.p.m.---------------- ($O_6$) | Maximum | Not over 20 | Not over 75 | Not over 150 | Over 150 |
| Turbidity p.p.m.------------ ($O_7$) | Maximum | Not over 10 except as result heavy rain | Not over 250 except as result heavy rain | | |
| Industrial or Domestic Sludge Deposits------------ ($O_8$) | | No deposits present | No deposits present | Slight to moderate localized | Moderate to heavy --general |
| Other Conditions------------ ($O_9$) | | No toxic substances, oils, tars, or free mineral acid at any time; no floating solids or debris, except from natural sources, only slight amounts of taste and odor producing substances occasionally present. | | | Toxic substances, oil or tars present frequently; taste and odor producting substances often present. |

NOTE: The above criteria were officially adopted by the former Maryland Water Pollution Control Commission on February 18, 1949.

Maryland Freshwater Stream Classification by Watershed, Contribution No. 106, Chesapeake Biological Laboratory, Solomons, Maryland, 1954. Using the classification techniques of Van Deusen, the U. S. Department of the Interior, Fish and Wildlife Service, brought the classifications for the Potomac River Basin above Great Falls up to date in 1960, and the results are presented in Potomac River Basin Report, Volume VIII, Appendix J, Fish and Wildlife, U. S. Army Engineer District, Baltimore, 1962. These classifications are presented by sub-reach for the Potomac River Basin in Maryland in Appendix VI of the present report. The classifications indicate only the types of fishlife which could be supported in the absence of pollution and do not describe the present fish population.

The West Virginia Department of Natural Resources, Division of Water Resources, maintains a network of stations in the Potomac River Basin of West Virginia where water quality is determined monthly. While the station at Shepherdstown is on the main stem of the Potomac River, several other stations indicate the quality of West Virginia tributaries entering the main stem.

# WATER QUALITY PROBLEMS

The Potomac River Basin in Maryland is composed of several major areas which present a logical sub-division for discussion of water quality. The various areas are different either in types of water quality problems or in physical characteristics. The major areas chosen for consideration of water quality problems in this report are as follows:

| | Tributary or Reach | River Miles from Mouth of Potomac River |
|---|---|---|
| I. | North Branch Potomac River | 381.6 - 285.1 |
| II. | Potomac River, South Branch to Conococheague Creek | 285.1 - 210.7 |
| III. | Potomac River, Conococheague Creek to Little Falls | 210.7 - 116.1 |
| IV. | Potomac River Estuary | 116.1 - 0.0 |

Tributaries entering these major reaches from States other than Maryland are considered on the basis of their effect upon the quality of water in Maryland streams. A map of each of the major reaches is included in Appendix VIII.

A summary of the water quality of the Potomac River Basin in Maryland is presented in the final chapter of this report. Figures 16 and 17, summarizing areas of water quality problems in the entire Basin in Maryland, are also located in Appendix VIII.

# I. NORTH BRANCH POTOMAC RIVER

| | |
|---|---|
| Length of North Branch Potomac River . . . | 96.5 miles |
| Area Draining to the North Branch . . . . | 1,384 square miles |
| North Branch and South Branch Join to Form the Potomac River at River Mile . . | 285.1 |

## Summary

The presence of mine drainage originating in both active and abandoned coal mining operations is detrimental to water quality throughout large portions of the North Branch Potomac drainage area. In addition, industrial and community wastewater discharges further degrade the water quality of the North Branch and of some tributaries. Water quality is discussed below by sub-reaches of the North Branch, and a map of the area is presented in Figure 12.

## Headwaters to Savage River (43.0 miles)

The North Branch Potomac River and most of the tributary streams from the headwaters to Savage River possess undesirable characteristics attributable to mine drainage. These streams are strongly acid (pH values as low as 3.0) and contain iron salts which precipitate from the water through natural oxidation and hydrolysis, coating long stretches of the stream bed with bright reddish-brown iron hydroxides. High manganese concentrations, which are generally characteristic of waters receiving mine drainage, are also present. Practically no aquatic life can survive such conditions, and little vegetation can grow in or close to the water's edge. (Algae attached to rocks may be observed at some locations, and one species of *Diptera* has been observed to inhabit a highly acid reach of the Youghiogheny River of the Ohio River Basin.[*]) The acid water is costly to treat for municipal or industrial purposes but would be more costly to use without treatment because of its corrosiveness. The acidity concentration of waters receiving mine drainage varies inversely with flow, generally being higher at the lower stream flows. Limestone which is soluble in acid is reported to be a dominant mineral in the area. However, the geologic formations near the surface through which the drainage seeps are evidently insoluble, since the dissolved solids content of these waters is generally less than 200 mg/l (milligrams per liter).

---

[*] Reppart, R. T., "Aquatic Life and the Acid Reaction," *Proceedings, Fifth Annual Symposium on Industrial Waste Control*, sponsored jointly by Frostburg State College and the Maryland Water Pollution Control Commission, May 7 and 8, 1964, Frostburg, Maryland.

The sources of mine drainage are the active and abandoned coal mines that are prevalent throughout the Western Maryland region. The Maryland Department of Water Resources is undertaking an exhaustive search for sources of mine drainage through stream sampling and field inspection. Also, the Public Health Service is studying the possibility of establishing an Acid Mine Drainage Demonstration Project in the North Branch Potomac River drainage area to test and evaluate methods of control. Such studies will ultimately lead to effective methods for controlling mine drainage at the source.

The only industrial waste discharges in the sub-reach from the headwaters to Savage River are from two coal washeries of the Alpine Coal Company at Henry, West Virginia, and the North Branch Coal Company at Bayard, West Virginia. The plant at Henry washes about 60,000 tons of coal per month, and that at Bayard will wash about 400,000 tons per month when completed, but is currently operating at less than one-fourth of this capacity. Coal dust and other finely divided solids are removed from freshly mined coal by water sprays. Some of the fines are discharged to the atmosphere, resulting in the surrounding countryside being covered with black dust which may be washed into streams during heavy rainfall. Large lagoons have been constructed to receive waste wash water at the collieries, which are apparently successful in settling out coal fines from wash waters. Only one recent severe incident of stream pollution by coal fines has been reported by local residents, and on that occasion the effects extended down the North Branch for about 40 miles to Luke, Maryland.

Water seeping through the bottom and walls of the lagoons constructed of spoil and fines from coal washing frequently produces an effluent equivalent to mine drainage. The seepage at Henry discharges principally to Elk Run about one mile upstream from its confluence with the North Branch Potomac River at River Mile 91.6 (miles above the mouth of the North Branch) and also to Deakin Run, a small tributary entering the North Branch at River Mile 92.0. The seepage at Bayard discharges to Buffalo Creek about one and one-half miles above its confluence with the

North Branch at River Mile 86.4 and to an abandoned mine shaft. It is likely that the abandoned mine shaft could overflow during periods of high rainfall.

The major tributary to the North Branch in this sub-reach is Stony River in West Virginia. Stony River, as it enters the North Branch at River Mile 78.3, contains high concentrations of iron and manganese. These concentrations have little effect on the North Branch because of the presence of mine drainage in this sub-reach. Two reservoirs on Stony River augment low flows and provide some dilution of the acid concentrations in the North Branch.

The only surface water supply in this sub-reach is taken from Wolfden Run for the unincorporated community of Shallmar, Maryland (population 100), which provides no treatment. Water quality data on Wolfden Run, which joins the North Branch at River Mile 70.4, indicate that the stream receives some mine drainage.

No community sewerage systems exist in this sub-reach. However, sewage discharges from individual homes have been observed entering Buffalo Creek from the town of Bayard, West Virginia, just above its confluence with the North Branch. Discharges of untreated or partially treated sewage from individual households are reported to be common for many small communities in the North Branch drainage area.

The average annual sediment discharge near the lower end of this reach (at Kitzmiller, Maryland, River Mile 68.9) is 94 tons per square mile, or 21,200 tons per year. Abram Creek in West Virginia, entering the North Branch at River Mile 71.3, contributes 21 tons per square mile on the average, or 1,100 tons per year. For comparison, the annual average sediment discharge for the entire Potomac River Basin above Washington, D. C. (at Point-of-Rocks, River Mile 159.5), is 113 tons per square mile, or 1,090,000 tons per year.

This reach of the North Branch and most of the tributaries in Maryland do not meet the minimum criteria for INCOPOT Class D (Table I) because of the presence of free acid, iron precipitates, and pH values below 6.0. The waters generally fall into the MDWR Class C (Table II) because of pH values below 3.8 and the presence of iron precipitates.

Savage River to New Creek (7.8 miles)

The Savage River is of good quality and suitable for most uses. However, manganese removal may be required at times to reduce concentrations to satisfy some uses. Frostburg, Maryland, obtains part of its water supply for 11,000 persons from the Savage River near its headwaters but does not remove manganese. Westernport, Maryland, obtains water from Savage Reservoir at the dam and supplies a population of 3,900 without practicing manganese removal. Piedmont, West Virginia, also receives its water supply for 2,700 persons from Savage River. Most of the Savage River drainage area is covered by forests and contains no sources of municipal or industrial pollution. Mine drainage enters Savage River only from Aaron Run (River Mile 1.1) and a smaller tributary (about River Mile 2.0). During drought periods, releases from the Savage Reservoir provide sufficient alkalinity to neutralize the small quantities of acid entering from these two streams. The mean discharge of the Savage River (164 cfs for a 15-year period of record) at its confluence with the North Branch Potomac River at River Mile 53.5 is about 40 per cent of that of the North Branch immediately upstream (437 cfs over 14 years) and thus provides significant neutralization of the acid in the North Branch.

The water temperature of the North Branch Potomac River just downstream (River Mile 53.3) from the Savage River ranges from 32°F. for long periods during the winter to a peak of 84° to 86°F. in the summer, occurring sometime between mid-June and mid-August. The difference between daily minimum and maximum temperatures during the winter is generally only 1° or 2°F., while in the summer, the average daily range is 6° to 8°F., and on some days may reach 14°F.

The West Virginia Pulp and Paper Company withdraws 40 mgd (million gallons per day) from the North Branch at River Mile 52.7. Part of the water is treated chemically and filtered for process and sanitary purposes. The town of Luke is also supplied with this treated water. Most of the water withdrawal at West Virginia Pulp and Paper Company is utilized for cooling and is neutralized to prevent corrosion. During periods of high water temperatures and low stream flows, a portion of the used cooling water is recycled to the River upstream over a reach of about 0.2 mile through spray nozzles. The North Branch at the plant intake is a mixture of water containing acid mine drainage from upstream areas and high quality water from Savage River. The flow ratio of Savage River to North Branch increases during periods of drought, because the regulated flow from Savage Reservoir is higher than that from the reservoirs on Stony River.

Several waste effluents from the paper mill discharge directly to the North Branch without treatment, their most significant characteristics being high alkalinity, B.O.D.* (biochemical oxygen demand), and temperature. The rocks on the bed of the River below the mill are coated with greenish-white lime wastes, in contrast to the reddish-brown rocks upstream. Lime waste discharges from the mill are such that most of the time the North Branch below the mill is highly alkaline and is acid at other times. The West Virginia Pulp and Paper Company has a program underway to reduce discharges of lime wastes. Lime recovery units, which are under construction, will be in operation early in 1966. The large volume of water used by the mill will continue to be neutralized to prevent corrosion; therefore, the return flows are expected to continue to provide some reduction in the acid concentrations of the North Branch following completion of the lime recovery process. Most of the wastes from the plant (other than cooling water and lime wastes) and the domestic wastes from Luke are transported through a rectangular conduit constructed along the side of the River from the plant to the Upper Potomac River Commission Waste Treatment Facility at Westernport, Maryland. Wastes from the City of Westernport are also treated at the facility, which provides secondary treatment by an activated sludge process (outfall at River Mile 51.0).

The West Virginia Pulp and Paper Company samples the North Branch Potomac River on week days above the plant (River Mile 53.1), below the plant (River Mile 52.4), and at River Mile 45.9, 5.1 miles below the Upper Potomac River Commission Waste Treatment Facility. Daily data on several water quality indicators at the three stations from January 1962 through February 1965, and for the effluent of the Waste Treatment Facility from December 1961 through March 1965, have been analyzed statistically for this summary. A summary of the results of this analysis is presented in Appendix II.

Georges Creek joins the North Branch Potomac River at Westernport (River Mile 51.4), 0.4 mile upstream from the Upper Potomac River Commission Waste Treatment Facility. Georges Creek, an alkaline stream at the headwaters, receives direct mine drainage discharges along its banks and from tributaries throughout its 17-mile length. Untreated sewage is discharged to the Creek from Frostburg, sewered population of 4,000 persons (River Mile 15.7); Lonaconing, 1500 persons (River Mile 8.1); Barton, 600 persons (River Mile 4.9); and from individual or small collection systems in several other communities. An interceptor is under construction to transport sewage from Frostburg to Cumberland, Maryland. While the interceptor will remove a major source of organic waste, the corresponding loss of this source of alkalinity is expected to result in some increase in acid concentrations in Georges Creek. The Lotz Wholesale Meats Company discharges an estimated 1,000 gpd (gallons per day) of settled slaughterhouse waste, with a B.O.D. of 175 mg/l, to Sandy Spring Run, 3.4 miles upstream from Georges Creek (confluence at River Mile 15.5). The Dashiell Dairy discharges its wastes to Georges Creek at River Mile 11.2. Even though the B.O.D. concentrations in the Creek near its mouth normally range between 10 and 20 mg/l, the dissolved oxygen levels seldom fall below 80 per cent of saturation, possibly because the stream acidity inhibits bacterial decomposition of the organic material present. Also, coliform bacteria concentrations* generally fall below 2,000/100 ml because of the bactericidal effects of the acid. Several small communities, serving a total population of about 6,500, obtain water supplies from tributaries of Georges Creek and provide only chlorination for treatment. The acidity from Georges Creek is neutralized much of the time by the alkaline waters of the North Branch (as a result of lime waste discharges from the West Virginia Pulp and Paper Company, to be discontinued by 1966). The average annual sediment load from the Georges Creek drainage area is quite high; i.e., 207 tons per square mile, or 15,000 tons per year.

---

* All values of B.O.D. presented in this report are for measurements at 20°C. for five days.

The town of Piedmont, West Virginia, discharges untreated sewage from 2,400 persons at River Mile 51.2. The flow of that discharge is estimated to be about 190,000 gpd.

The effluent from the Upper Potomac River Commission Waste Treatment Facility serving the West Virginia Pulp and Paper Company, Luke and Westernport, is distributed through subsurface nozzles across the center section of the North Branch at River Mile 51.0. Analyses of quality indicators of the waste effluent and the calculated water quality of the North Branch immediately downstream from the facility are summarized in Appendix II.

---

* All coliform bacteria counts (or concentrations) in this summary are given as determined at 35°C. and are expressed as monthly geometric means.

Cresaptown discharges an estimated 280,000 gpd of sewage effluent, after primary treatment, to the North Branch at River Mile 29.5. The waste loading is estimated to be about 390 pounds of B.O.D. per day.

The Celanese Fibers Company at Amcelle, Maryland, withdraws an average of 40 mgd of cooling water from the North Branch at River Mile 28.9, and up to 53 mgd during periods of high water temperatures. An additional 2.0 mgd are obtained for process and sanitary purposes from the City of Cumberland. The plant has about 3,000 employees. Fly ash is settled and sanitary wastes undergo decomposition in a large lagoon; whereas, process wastes receive treatment in another lagoon. The plant produces acetate fibers, polymers of cellulose acetate, and cellulose proprionate. The total average waste loading to the River is about 15,000 pounds of B.O.D. per day from this plant. A larger lagoon system, which is expected to provide a higher degree of treatment for organic wastes, is under design.

The dissolved oxygen concentrations seldom fall below 50 per cent of saturation above the Celanese plant, even during periods of high water temperatures. The water temperatures at that point range from 32°F. in the winter to 89°F. at times during the summer. Based on five years of record, during the warmest ten-week period of the year, the temperature averaged 78°F., and 84°F. during the warmest week. The mean water temperature for the month of July is 78°F., as compared to 74°F. at Keyes (the last sampling station upstream), showing an average rise in mean temperatures of 4°F. between the two points. Coliform bacteria, which were generally present in the order of magnitude of 100,000 to 1,000,000/100 ml about 10 miles below Keyser before completion of the Keyser sewage treatment plant, were reduced to about 1,000 to 100,000/100 ml at the Celanese plant, even with some additional bacterial loadings immediately upstream. Color and odor from the paper-mill waste are still detectable above the Celanese plant.

Immediately below the Celanese plant, the coliform bacteria counts increase by about 10,000 to 100,000/100 ml. During the warmer months of the year, the dissolved oxygen content below the plant is much less (near zero at times) than above the plant, while during the colder months, there is little change. Water temperatures below the plant are increased about 1°F. during periods of high river discharge and up to 9°F. during periods of low river discharge.

Bowling Green, Maryland, discharges an estimated 180,000 gpd of sewage effluent, after primary treatment, to the North

Branch at about River Mile 25.0. The loading after treatment from the 2,250 persons served is estimated to be 250 pounds of B.O.D. per day. The treatment plant was constructed in 1964 by the Bowling Green Sanitary District.

The Kelly-Springfield Tire Company obtains 2.9 mgd from the North Branch for cooling purposes at River Mile 23.4 and discharges the heated water just downstream. Water for sanitary and boiler use is obtained from Cumberland at an average rate of 1.9 mgd, and the sanitary wastes are discharged to Cumberland sewers. No process wastes are generated at this plant.

The Potomac Edison Company obtains 675 gpd from the North Branch for cooling purposes at River Mile 22.6 and discharges the heated water just downstream. An average of 32,000 gpd are obtained for sanitary and boiler uses from the City of Cumberland. Sanitary wastes are discharged to Cumberland sewers. The effect of the cooling water discharges of the two adjacent plants (Kelly-Springfield and Potomac Edison) is to raise the temperature of the River about 2°F. during high stream flows and up to 6°F. during low stream flows, reaching 88°F. at times.

A pool created by a low dam on the North Branch at River Mile 21.9 provides an adequate depth for the cooling water intakes of the Kelly-Springfield Tire Company and the Potomac Edison Company. The velocity of the River decreases in this pool, permitting suspended solids, including organic matter from the numerous waste-water discharges upstream, to settle out at this point. Conditions are created which permit organic solids to accumulate on the bottom of the pool and decompose at a high rate. Numerous bubbles may be seen breaking at the surface as a result of anaerobic decomposition taking place at the bottom.

The entire sub-reach from New Creek to Wills Creek does not meet the minimum requirements for INCOPOT Class D because of B.O.D. values over 5.0 mg/1, and offensive odors which occur most of the time. The entire sub-reach falls into MDWR Class C because of coliform bacteria concentrations over 10,000/100 ml, B.O.D. values over 7.0 mg/1, and the presence of taste and odor producing substances.

### Wills Creek to South Branch (21.7 miles)

Wills Creek, as it enters Maryland from Pennsylvania, carries the untreated domestic wastes from Hyndman, Pennsylvania, a town of 1,124 persons. Hyndman is located approximately 8 river miles above the Maryland State line. The average annual sediment discharge below Hyndman is 127 tons per square mile, or 18,500 tons per year. Untreated sewage from a portion of Frostburg, Maryland, is discharged into Jennings Run, which enters Wills Creek at River Mile 4.4. The Appalachian Stone Division of the Martin-Marietta Corporation obtains water from Wills Creek at River Mile 4.1 for washing sand and gravel and returns the water to the stream after settling. The Manley Sand Division of the Martin-Marietta Corporation also maintains a similar operation on Wills Creek at River Mile 3.1. La Vale, Maryland, population of 4,031, discharges untreated sewage to Braddock Run, which joins Wills Creek at River Mile 2.3. An interceptor sewer is under construction to transport sewage from Frostburg and La Vale to Cumberland for treatment. Wills Creek has a high capacity for assimilating organic wastes, and the dissolved oxygen concentration near its mouth has been found to be high. Both Jennings and Braddock Runs occasionally show signs of acid mine drainage; however, Wills Creek contains sufficient alkalinity to neutralize considerable amounts of acid. At least part of the time more than trace concentrations of manganese can be found in Wills Creek near the mouth. Wills Creek joins the North Branch Potomac River at River Mile 21.7 within the City of Cumberland, and below the low dam on the North Branch mentioned above.

Ridgeley, West Virginia, discharges untreated sewage from 1,000 persons to the North Branch at about River Mile 21.5. The loading is estimated to be about 170 pounds of B.O.D. per day.

Cumberland, Maryland, discharges sewage effluent from 33,000 persons to the North Branch at River Mile 18.2 after primary treatment. The wastes from several industries, including Cumberland Brewing Company, Cumberland Coca-Cola Bottling Company, Kelly-Springfield Tire Company (sanitary waste only), Liberty Milk Company, Potomac Edison Power Company (sanitary waste only), Potomac Farms Quality Dairy Products, Queen City Brewing Company, and Queen City Cooperative Dairy, Inc., account for the high total waste effluent discharge of 5.0 mgd from the Cumberland sewage treatment plant.

Evitts Creek enters the North Branch at River Mile 17.5. Cumberland obtains its water supply from two reservoirs on Evitts Creek in Pennsylvania at River Miles 14.3 and 13.0. The community of Growdenvale, Maryland, discharges sewage effluent to Evitts Creek from about 65 persons after primary treatment at River Mile 2.0. Evitts Creek is alkaline and has no known water quality problems.

The Pittsburgh Plate Glass Company discharges about 2.0 mgd of industrial wastes to the North Branch at River Mile 11.3

and about 400,000 gpd of sanitary wastes from about 1,200 employees, after primary treatment, at River Mile 11.1. The industrial wastes containing iron oxide and silica oxide are treated with acid to reduce the pH and are settled before discharge.

Past data have shown that the high iron and manganese contents from upstream acid mine drainage and taste, odor, and color from paper-mill wastes persist in the North Branch downstream below Cumberland.

Patterson Creek enters the North Branch from West Virginia at River Mile 9.0. The average annual sediment discharge from Patterson Creek, as measured at Headsville, West Virginia, is 84 tons per square mile, or 18,400 tons per year.

Because of a lack of current water quality data for the North Branch and the Potomac River between Cumberland, Maryland, and Hancock, Maryland (River Mile 237.5), a special study of that reach was made by the Chesapeake Bay-Susquehanna River Basins Project of the Public Health Service in July 1965. At each of the five stations established during the study, four sampling runs were made. Three runs were performed during the daylight hours, and one was performed prior to sunrise to evaluate possible algal activity. The results of that survey are presented in Appendix III. Above the Cumberland sewage treatment plant effluent outfall, at River Mile 19.6, the B.O.D. averaged 1.8 mg/l; dissolved oxygen, 3.6 mg/l; coliform bacteria, 9,900/100 ml (geometric mean); and hardness, 230 mg/l. The dissolved oxygen at 3:00 a.m. (3.2 mg/l) was slightly lower than at 2:30 p.m. of the same day (3.9 mg/l). The water temperature and total dissolved solids averaged 82.8°F. and 450 mg/l, respectively. Average stream flow during the survey was 168 cfs.

Downstream of the Cumberland sewage treatment plant and the Pittsburgh Plate Glass Company industrial waste outfalls, the average total dissolved solids during the special survey increased to 490 mg/l and the total hardness to 250 mg/l, while coliform bacteria count decreased to 2,300/100 ml. Factors explaining the reduced bacterial counts would be the natural die-off in the seven miles of stream between the sampling points, especially in the pool behind a low dam on the North Branch at the Pittsburgh Plate Glass Company, and the diluting effects of stream flows from Evitts Creek and other small tributaries. The B.O.D. dropped slightly to an average of 1.1 mg/l, even though on two sampling runs the change was not significant. There was no change in the average dissolved oxygen concentration (3.6 mg/l) between the two stations. The water temperature dropped an average of 3.6°F. to 79.2°F.; this would be expected because of artificially elevated water temperatures at the upstream station from industrial cooling water discharges.

A third sampling station in the special survey of July 1965 was located at Oldtown, Maryland, 2.2 miles upstream from the mouth of the North Branch. The coliform bacteria count (2,300/100 ml) was the same as that for the last station upstream (a distance of 9.0 miles). The average B.O.D. increased to 1.7 mg/1, and the average dissolved oxygen concentration increased to 6.2 mg/1. The dissolved oxygen concentration in the middle of the night (5.1 mg/1) was 2.2 mg/1 lower than on the same day in the late afternoon (7.3 mg/1), indicating the possible presence of photosynthetic plants. The total dissolved solids averaged 510 mg/1, the total hardness averaged 230 mg/1, and the average water temperature was 80.6°F.

Wills Creek does not meet the minimum requirements for INCOPOT Class D because of B.O.D. concentrations higher than 5.0 mg/1 and falls into MDWR Class C because of B.O.D. concentrations above 7.0 mg/1 and coliform bacteria counts over 10,000/100 ml. Braddock Run and Jennings Run of Wills Creek have these same classifications because of mine drainage conditions in addition to untreated sewage discharges. Evitts Creek in Maryland, except possibly immediately below the sewage effluent outfall of Growdenvale, may be classified as INCOPOT Class B and MDWR Class A. The North Branch in this sub-reach does not meet the minimum requirements for INCOPOT Class D because of average dissolved oxygen concentrations below 4.0 mg/1 in the upper portion and the presence of odors throughout, and falls into MDWR Class C because of the same reasons plus coliform bacteria concentrations over 10,000/100 ml in the upper portion.

## II. POTOMAC RIVER, SOUTH BRANCH TO CONOCOCHEAGUE CREEK

| | | |
|---|---|---|
| Upstream River Mile . . . . . . . . . . . . | 285.1 | |
| Downstream River Mile . . . . . . . . . . . | 210.7 | |
| Length of Reach . . . . . . . . . . . . . . | 74.4 | miles |
| Area Draining Directly to Reach . . . . . | 4,782 | square miles |
| Total Drainage Area to Downstream Limit of Reach . . . . . . . . . . . . | 6,110 | square miles |

### Summary

The Potomac River is formed 285.1 miles above its mouth by the confluence of the North Branch from Maryland and the South Branch from West Virginia. The North Branch, as it enters the Potomac River, contains iron, manganese, and taste and odor producing substances in greater than trace concentrations. Water of higher quality from large tributaries in West Virginia, including the South Branch and the Cacapon River, provide dilution of these undesirable constituents from the North Branch. At the lower end of the reach, after receiving dilution flows and undergoing self-purification, the quality is good, except that some taste and odor producing substances are still present. Surface run-off and several small communities constitute the only waste sources within this reach. A map of this reach is presented in Figure 13.

### South Branch to Tonoloway Creek (47.6 miles)

The South Branch Potomac River, as it joins the North Branch to form the Potomac River at River Mile 285.1, is of a quality suitable for most uses. Normally, the dissolved oxygen content is 80 per cent of saturation or higher, and the B.O.D. is less than 3.0 mg/l. Manganese removal, however, may be necessary to reduce concentrations to satisfy some water uses. The South Branch contains some taste and odor producing substances, but to a lower degree than the North Branch. The average stream discharge of the South Branch (1,253 cfs for a 39-year period of record as measured 13 miles upstream from its mouth) is about 67 per cent of the average discharge of the North Branch (1,867 cfs for a 25-year period), and, therefore, provides considerable dilution of some constituents in the North Branch, such as iron, color, tastes and odors. The alkalinity of the South Branch normally ranges from 50 to 100 mg/l. The coliform bacteria concentrations of the South Branch usually fall below 2,000/100 ml. The average annual sediment discharge from the South Branch is 107 tons per square mile, or 157,000 tons per year. Comparable sediment figures for the North Branch are 138 tons per square mile, or 225,000 tons per year. While the North Branch contributes more sediment per square mile of tributary area, it also contributes more water in about the same proportion, and thus the suspended solids content of these two rivers is quite comparable.

The town of Paw Paw, West Virginia (River Mile 276.8), discharges about 50,000 gpd of untreated wastes from 750 persons to the Potomac River. A waste stabilization lagoon is under construction, and, after completion, the waste loading discharged to the River is estimated to be about 15 pounds of B.O.D. per day. A reduction in coliform bacteria of about 90 per cent can also be expected.

The average annual sediment discharge of the Potomac River at Paw Paw, West Virginia, is 123 tons per square mile, or 383,000 tons per year.

A previously mentioned survey by the Chesapeake Bay-Susquehanna River Basins Project of the Public Health Service in July 1965, indicated that the dissolved oxygen concentration of the Potomac River at Paw Paw, West Virginia (River Mile 276.5), averaged 6.9 mg/l; the B.O.D., 1.3 mg/l; the total dissolved solids, 320 mg/l; the total hardness, 150 mg/l; and the coliform bacteria concentration, 9,500/100 ml. The sewage outfall at Paw Paw, located 0.3 mile upstream of the sampling station, may have some influence on the coliform concentrations. The average stream flow at Paw Paw during the survey was 597 cfs, as compared to a long-term average of 3,120 cfs (25 years of record).

Most of the drainage area of the Potomac River within this sub-reach is covered by forests. Farm land occurs intermittently.

The Cacapon River joins the Potomac River from West Virginia at River Mile 247.9. Available data indicate that the water quality of the Cacapon River is excellent for most uses. The average stream discharge of the Cacapon River (564 cfs for a 40-year period of record, measured 6.5 miles from the mouth) is only about 16 per cent of the annual average stream discharge of the Potomac River (3,435 cfs for a 31-year period) just upstream from their confluence; thus, in general, a slight improvement of water quality in the Potomac River by the dilution could be expected. The dissolved oxygen concentration in the Cacapon River seldom falls below 90 per cent of saturation, and the B.O.D. is normally below 3.0 mg/1. Coliform bacteria are generally below 1,000/100 ml, and the suspended solids concentrations generally are less than 50 mg/1. Total solids are normally less than 150 mg/1, and turbidity is less than 10 standard scale units. The average annual sediment discharge of the Cacapon River is 64 tons per square mile, or 43,600 tons per year, about one-half of the areal rate in the Potomac River Basin above Paw Paw.

The most downstream station of the special Public Health Service survey of July 1965 was at Hancock, Maryland (River Mile 239.1). The Potomac River at that point (37.4 miles from the next upstream station) had an average dissolved oxygen concentration of 7.6 mg/1. The dissolved oxygen concentration of 6.8 mg/1 at 7:00 a.m. was 2.0 mg/1 lower than the 8.8 mg/1 found at 5:00 p.m. on the same day, indicating the possible presence of photosynthetic aquatic plants. The B.O.D. averaged 1.0 mg/1; total dissolved solids, 300 mg/1; the total hardness, 140 mg/1; and the mean coliform bacteria count was 2,300/100 ml. The stream flow at Hancock during the survey averaged 907 cfs and at Paw Paw was 597 cfs. The U. S. Geological Survey has determined the travel time between Paw Paw and Hancock at 1,010 cfs (measured at Paw Paw) to be 48.6 hours, a velocity of 0.78 miles per hour. The average stream flow of the Potomac River at Hancock is 3,999 cfs (31 years of record).

Hancock, Maryland, a city of 2,000 persons, obtains its water supply (200,000 gpd) from Little Tonoloway Creek about one mile above its confluence with the Potomac River at River Mile 238.8 and maintains an emergency pump on the Potomac River at River Mile 239.0. No recent samples of the Potomac River supply at Hancock have been taken, although the Little Tonoloway Creek supply is reported to contain about 200 mg/1 of hardness and about 180 mg/1 of alkalinity.

Warm Springs Run, as it enters the Potomac River from West Virginia at River Mile 238.3, receives untreated sewage from over 700 persons at Berkeley Springs, West Virginia, 7.0 miles upstream, and industrial and sanitary wastes from the Pennsylvania Glass Sand Company, 4.0 miles upstream. The Pennsylvania Glass Sand Company employs about 225 persons. These industrial wastes of about 180,000 gpd, with high concentrations of suspended solids, are treated by settling. Before the recent construction of a settling basin at the plant, suspended solids concentrations of about 10,000 mg/1 were found in Warm Springs

Run. The degree of reduction of suspended solids by the present treatment has not been established.

The Potomac River in the upper portion of this sub-reach may be classified as INCOPOT Class D because of mean coliform bacteria counts over 5,000/100 ml and the presence of taste and odor producing substances, and MDWR Class C because of the presence of taste and odor producing substances. After self-purification and dilution, the lower portion of the sub-reach may be classified as INCOPOT Class C because of mean coliform bacteria counts between 500 and 5,000/100 ml, and MDWR Class B because of mean coliform bacteria counts between 2,000 and 10,000/100 ml (assuming for both classifications that taste and odor producing substances are present only occasionally). Little Tonoloway Creek may be classified as INCOPOT Class B and MDWR Class A.

Tonoloway Creek to Conococheague Creek (26.8 miles)

Tonoloway Creek enters the Potomac River at River Mile 237.5. The City of Hancock discharges about 150,000 gpd of sewage effluent from 2,000 persons, after treatment by waste stabilization lagoon, to Tonoloway Creek at about River Mile 0.8. An additional 200 persons at Hancock discharge untreated sewage to the Creek. The estimated total organic loading to the Creek is about 80 pounds of B.O.D. per day.

Back Creek, which enters the Potomac River at River Mile 225.9, from West Virginia, has an average annual sediment discharge of 51 tons per square mile, or 12,400 tons per year. Back Creek receives untreated sewage from about 500 persons throughout its drainage area, but these wastes are stabilized to negligible levels before the Creek reaches the Potomac River. A sand and gravel operation on Back Creek does not appear to impair water quality.

Much of the drainage area to this sub-reach is covered by forests with intermittent farm land.

This sub-reach down to Back Creek has been clouded and covered with silt fines from Warm Springs Run (River Mile 238.3). Since the construction of the settling basin at the glass-sand plant on Warm Springs Run, the present concentration of suspended solids is unknown.

The City of Hagerstown, Maryland, obtains most of its water supply from the Potomac River at River Mile 212.0. This source serves 57,000 persons, while mountain springs serve an additional 28,000 persons. The Potomac source is treated to control tastes and odors.

The only current water quality data available for this sub-reach are those obtained for the Public Health Service Water Pollution Surveillance System at Williamsport, Maryland, in cooperation with the Hagerstown Water Department. Periodic samples are taken above the water supply intake at River Mile 212.5. Five years of data (1960 - 1965) from that station have been analyzed, and a summary of the results is presented in Appendix IV. These analyses include 35 observations for dissolved oxygen, 36 for B.O.D., 180 for coliform bacteria, 197 for pH, intermediate numbers for other indicators, and 8 observations for C.O.D. (chemical oxygen demand). The summary shows that the monthly average dissolved oxygen concentration reached a minimum of 7.5 mg/l in August, with the minimum individual observation of 6.0 mg/l also occurring in August. The monthly average B.O.D. reached a maximum concentration of 1.3 mg/l in September and November, with a maximum individual value of 2.6 mg/l occurring in November. The maximum monthly mean coliform bacteria concentration was reported as 590/100 ml.

The monthly average water temperatures of the Potomac River at Williamsport range from 35.2°F. in January to 77.2°F. in July, with the maximum individual value of 82.0°F. having occurred in July. The maximum individual determination of gross beta radioactivity of 141 pc/l (picocuries per liter, a picocurie being one-millionth of a microcurie, or commonly called a micro-microcurie), the maximum monthly (February) average of 43 pc/l, and the annual average of 19 pc/l, are all well under the maximum permissible concentration of 1,000 pc/l for mixtures of unknown radionuclides.

As noted in the preceding discussion, current water quality data for this sub-reach are minimal; however, based upon the known quality of water at Williamsport, Maryland (River Mile 212.5), the sub-reach may be classified as INCOPOT Class C because of monthly mean coliform bacteria counts between 500 and 5,000/100 ml, and MDWR Class A because of monthly mean coliform bacteria counts between 100 and 2,000/100 ml. Taste and odor producing substances occur only occasionally.

## III. POTOMAC RIVER, CONOCOCHEAGUE CREEK TO LITTLE FALLS

| | | |
|---|---|---|
| Upstream River Mile . . . . . . . . . . . . | 210.7 | |
| Downstream River Mile . . . . . . . . . . . | 116.1 | |
| Length of Reach . . . . . . . . . . . . . . | 94.6 | miles |
| Area Draining Directly to Reach . . . . . | 5,470 | square miles |
| Total Drainage Area to Downstream Limit of Reach . . . . . . . . . . . . . | 11,580 | square miles |

### Summary

The waters of the Potomac River from Conococheague Creek to Little Falls are moderately hard (annual averages between 100 mg/l and 125 mg/l). Monthly mean coliform bacteria concentrations generally exceed 2,000/100 ml immediately below major tributaries, and die-off to lower values between these tributaries. Maximum monthly mean coliform bacteria concentrations of 9,000/100 ml occur at Point-of-Rocks, Maryland, and then decrease to 3,900/100 ml at Great Falls, Maryland. These maximum values commonly occur at high stream flows, indicating that surface drainage may be a principal source of the bacteria. Average monthly dissolved oxygen concentrations in the Potomac River are generally above 6.0 mg/l, but fall to about 3.0 mg/l at times. Two thermo-electric generating stations (at Williamsport, Maryland, and just downstream from the Monocacy River) raise the temperature of the Potomac River by several degrees (F.), but there appears to be no serious effect on water quality. Manganese is present in concentrations which may require removal for some uses in upstream portions of this reach, but is diluted to insignificant levels downstream. Tastes and odors are present at times in municipal water supplies drawn from this reach. Several tributaries of the Potomac River in this reach have degraded water quality because of municipal and/or industrial waste discharges. Conococheague Creek contains taste and odor producing substances and hardness concentrations of about 180 mg/l. Antietam Creek contains moderate concentrations of coliform bacteria, is low in dissolved oxygen below Hagerstown (1.0 mg/l at times), and has a hardness from 190 mg/l upstream to 225 mg/l downstream. The Monocacy River has been found to have low concentrations of dissolved oxygen just below the Pennsylvania State line and below Frederick, Maryland, and at times to contain taste

and odor producing substances. A map of this reach of the Potomac River is presented in Figure 14.

### Conococheague Creek to Antietam Creek (30.5 miles)

Conococheague Creek, upstream of the Maryland-Pennsylvania State line, receives, following secondary treatment, 100,000 gpd from 850 persons at the Scotland Orphanage and 300,000 gpd from 1,700 persons at the Dixon TB Hospital in Pennsylvania; 3,000,000 gpd of secondary sewage plant effluent from 22,000 persons at Chambersburg, Pennsylvania; 500,000 gpd of canning wastes from the H. J. Heinz Company, and 25,000 gpd from Path Valley Esso at Chambersburg, both after secondary treatment; 220,000 gpd of secondary effluent from 2,300 persons at Mercersburg, Pennsylvania; 220,000 gpd of tannery wastes from Lowengart and Company at Mercersburg, after primary treatment; 125,000 gpd of secondary effluent from 4,000 persons at Greencastle, Pennsylvania; and 12,000 gpd of meat packing wastes from the Greencastle Packing Company at Greencastle, after secondary treatment. Although data are limited, Conococheague Creek appears to be of good quality with respect to dissolved oxygen (greater than 6.5 mg/l) and B.O.D. content (less than 1.5 mg/l) as it enters Maryland. However, substances producing tastes and odors are present, hardness is about 180 mg/l, and the alkalinity is about 160 mg/l. The W. D. Byron and Sons Tannery at Williamsport, Maryland, obtains 210,000 gpd of water from Conococheague Creek at River Mile 0.4, 84,000 gpd from a spring, and 66,000 gpd from Williamsport, and discharges 300,000 gpd of process wastes to the Creek at River Mile 0.3 after screening, neutralization, aeration, and settling. Conococheague Creek, as it enters the Potomac River at River Mile 210.7, has a hardness of about 150 mg/l, alkalinity of about 130 mg/l, and taste and odor producing substances. Conococheague Creek, as measured at Fairview, Maryland, 18 miles upstream of its mouth, discharges a relatively high average annual sediment load of 217 tons per square mile, or 107,000 tons per year.

The Potomac Edison Company, R. Paul Smith Station, obtains an average of 72.0 mgd of cooling water plus 42,000 gpd for boiler and other uses from a low dam on the Potomac River at River Mile 210.6, just below the entry of Conococheague Creek, and returns the used waters to the Potomac River just downstream. The maximum usages during hot weather are 192.0 mgd for cooling and 641,000 gpd for boiler and other uses. Fly ash is removed from wash waters by settling before discharge. The rise in temperature of the Potomac River is not pronounced, usually being no more than 3.0°F.

from 11,000 persons at Waynesboro, Pennsylvania; 21,000 gpd of secondary sewage effluent from 350 persons at the E. U. B. Orphanage in Pennsylvania; and 140,000 gpd of secondary sewage effluent from 1,500 military residents plus 280 civilian employees at Fort Ritchie (National Guard), Maryland. The average of six samples taken in September and October of 1958 just below the State line showed that the water quality was good with respect to dissolved oxygen concentration (7.8 mg/l) and B.O.D. (1.5 mg/l). Antietam Creek at that point had a hardness and an alkalinity of 186 mg/l and 162 mg/l, respectively, and a coliform count of 8,100/100 ml. Hagerstown obtains part of its water supply from mountain springs of high quality in the headwaters of Little Antietam Creek (the more northernly of the two Little Antietam Creeks). Marquette Cement Manufacturing Company at Security, Maryland, obtains 8.1 mgd of water from Antietam Creek at River Mile 27.0 and discharges 7.8 mgd of cooling water at River Mile 26.8. The Fairchild Stratos Corporation discharges about 30,000 gpd of sanitary wastes from 4,600 employees, after secondary treatment, and 50,000 gpd of cooling water to the West Branch of Marsh Run, about 5.0 miles upstream from the confluence of Marsh Run with Antietam Creek at River Mile 26.4. The Municipal Electric Light Plant obtains an average of 33.4 mgd of cooling water and a maximum of 62.2 mgd from a low dam impoundment on Antietam Creek at River Mile 23.8 and discharges the used cooling water just downstream. The Western Maryland Railway Company discharges 150,000 gpd of engine and railroad car cleaning wastes, after settling and oil removal, to a small tributary at Hagerstown, Maryland, which enters Antietam Creek at River Mile 23.7. Potomac Creamery Company discharges an unknown quantity of cooling water to a branch of that same small tributary. Hagerstown discharges about 3.8 mgd of secondary sewage effluent from 36,000 persons to Antietam Creek at River Mile 22.6. Sampling upstream and downstream of the effluent outfall shows that under average stream flow conditions (265 cfs average over 40 years at Sharpsburg, Maryland), the B.O.D. increases from about 1.0 mg/l above the outfall to about 2.5 mg/l below the outfall; the dissolved oxygen concentration decreases from about 98 per cent to about 30 per cent of saturation in hot weather. Coliform bacteria concentrations increase from 500 to 3,000/100 ml. The alkalinity below the Hagerstown outfall ranges from 150 to 200 mg/l. Funkstown, Maryland, discharges to Antietam Creek at River Mile 21.4 about 75,000 gpd of wastes from 970 persons, after treatment by a stabilization lagoon. The Maryland State Reformatory for Males at Breathedsville, Maryland, discharges 125,000 gpd of secondary sewage effluent from 1,250 persons to Antietam Creek at River Mile 12.4. Boonsboro, Maryland, discharges 120,000 gpd of sewage effluent from 1,200 persons after treatment by a waste stabilization lagoon, to a tributary of Little Antietam Creek (southern). Boonsboro obtains its water supply from Gilardi Run of Little Antietam Creek (southern) and from several springs. Keedysville, Maryland, does not have a municipal sewerage system but is estimated to discharge about 47,000 gpd of untreated sewage from 320 persons through individual and small sewerage systems to Little Antietam Creek (southern) about 1.0 mile above its confluence with Antietam Creek. The total organic loading from these four discharges is about 140 pounds of B.O.D. per day. Untreated sewage from small collection systems in a portion of Sharpsburg, Maryland, discharges to Antietam Creek. Antietam Creek near Sharpsburg, Maryland, has a high average annual sediment discharge of 193 tons per square mile, or 54,200 tons per year. Although no recent water quality data are available on Antietam Creek except at Hagerstown, the results of six samples taken in September and October of 1958 showed that dissolved oxygen concentrations remained high throughout Antietam Creek, even with B.O.D. loadings higher than at present. The hardness near the mouth was about 225 mg/l, and the alkalinity about 175 mg/l.

Harpers Ferry, West Virginia, discharges untreated sewage from 250 persons to the Potomac River and the Shenandoah River at their confluence.

The Shenandoah River enters the Potomac River from West Virginia at River Mile 171.5 and transports the residual of municipal wastes and industrial wastes of a wide variety from Virginia and West Virginia. The Shenandoah River at Millville, West Virginia, has a moderate average annual sediment discharge of 120 tons per square mile, or 365,000 tons per year. The Public Health Service has maintained a station of the National Water Pollution Surveillance System at Berryville, Virginia, since June 1961, in cooperation with the U. S. Army Corps of Engineers. Mineral analyses were performed weekly for a total of about 150 observations through February 1965, while smaller numbers of observations were made for dissolved oxygen (73), B.O.D. (39), and certain other indicators. This station is about 25 miles upstream of the mouth of the Shenandoah River and, therefore, does not show the effects of several downstream waste discharges in West Virginia. However, by considering the sampling results at Berryville along with the results of samples obtained in September and October of 1958 at the mouth of the Shenandoah River, a reasonable description of the water quality of the Shenandoah River entering the Potomac River may be given. The 48-year average stream flow of the Shenandoah River at Millville, West Virginia, 5.0 miles upstream from its mouth, is 2,677 cfs, as compared with an average flow (including the Shenandoah River) of the Potomac River at Point-of-Rocks, Maryland, of 9,215 cfs over 68 years of record. The results from the analysis of approximately three and one-half years of sampling at Berryville are briefly summarized in Appendix IV. This analysis indicates that the monthly average dissolved oxygen concentrations reached a minimum of 7.2 mg/l in July, with the lowest observed concentration of 5.1 mg/l occurring in August. In the month of August, the monthly average B.O.D. reached a maximum concentration of 5.1 mg/l, and a maximum individual value of 6.7 mg/l was observed. The maximum monthly mean coliform bacteria concentration of 300/100 ml occurred in October. Recent results of sampling by the Interstate Commission on the Potomac River Basin at West Virginia Highway 9, about six miles from the mouth of the Shenandoah River, showed that the mean coliform counts for individual months reached as high as 6,300/100 ml.

The monthly average water temperatures of the Shenandoah River at Berryville ranged from 35.7°F. in January to 77.7°F. in July, with the maximum individual value of 82.4°F. occurring in July. The maximum monthly average hardness of 181 mg/l occurred in October (at lowest flows) as did the maximum individual value of 240 mg/l; the annual average hardness concentration appears to be approximately 146 mg/l. The maximum individual determination of gross beta radioactivity of 136 pc/l (picocuries per liter), the maximum monthly (March) average of 70 pc/l, and the annual average of 37 pc/l, are all well under the maximum permissible concentration of 1,000 pc/l for mixtures of unknown radionuclides. Other constituents measured were well within acceptable limits. Samples obtained in 1958 at the mouth indicate that iron, manganese, and taste and odor producing substances were present in concentrations which may require treatment prior to satisfying some water uses. Monthly sampling of the Shenandoah River at River Mile 7.4 in 1963 by the West Virginia Department of Natural Resources, indicated that the quality was essentially the same as at Berryville, except that higher B.O.D. concentrations (up to 6.9 mg/l in June) were found.

The Baltimore and Ohio Railroad locomotive maintenance shop at Brunswick obtains its water supply from the Potomac River at River Mile 165.5 and discharges the waste cleaning waters, after settling and oil removal, at River Mile 165.3.

Brunswick, Maryland, discharges about 250,000 gpd of sewage effluent from 3,700 persons, after primary treatment, to the Potomac River at River Mile 165.2. This loading amounts to about 410 pounds of B.O.D. per day when the treatment plant is operating efficiently. The Maryland State Department of Health has recommended replacement of the treatment plant.

Catoctin Creek, Maryland (Catoctin Creek of Virginia is discussed in the following section), enters the Potomac River at River Mile 162.4. Myersville, Maryland, discharges 25,000 gpd of sewage effluent from 450 persons, after primary treatment, to Catoctin Creek at about River Mile 24.7. The loading from Myersville is about 50 pounds of B.O.D. per day. Myersville obtains its water supply from springs along Broad Run, which enters Catoctin Creek at River Mile 5.8, and provides only chlorination. Middletown, Maryland, discharges 60,000 gpd of sewage effluent from 1,100 persons, after primary treatment, to Catoctin Creek at about River Mile 15.4. The loading from Middletown is about 120 pounds of B.O.D. per day. Catoctin Creek near Middletown has a low average annual sediment discharge of 47 tons per square mile, or 31,200 tons per year. While no recent water quality data are available for Catoctin Creek, the results from six samples taken in September and October of 1958 indicated that the hardness and alkalinity were quite low, being 55 and 50 mg/l, respectively.

Catoctin Creek, Virginia, enters the Potomac River at River Mile 159.8. Catoctin Creek receives about 105,000 gpd of sewage effluent from 850 persons, after primary treatment, at Purcellville, Virginia, about 110,000 gpd of meat packing wastes from J. Lynn Cornwell, Inc., at Purcellville, and untreated sewage from individual or small collection systems at Lovettsville, Virginia.

At Point-of-Rocks, Maryland (River Mile 159.5), the Potomac River has an average stream discharge of 9,215 cfs (68 years of record); however, the range of stream discharges is great, with fluctuations often occurring rapidly. During lower stream discharges, the Potomac River at Point-of-Rocks is moderately hard (150 mg/l at 2,000 cfs), while at high stream discharges, hardness is low (60 mg/l at 50,000 cfs and higher). The average annual sediment discharge is 113 tons per square mile, or 1,090,000 tons per year. The sediment discharge varies greatly throughout the year here, as at most locations in the Basin. In 1962, the monthly sediment discharge ranged from 295 tons in September to 601,653 tons in March. Even during low stream discharges (about 1,500 cfs), and at highest temperatures, the monthly average dissolved oxygen concentrations do not fall below about 6.0 mg/l. Monthly average B.O.D. concentrations range between 1.0 and 6.1 mg/l, with an annual average concentration of 2.5 mg/l. Generally, the higher B.O.D. concentrations occur at higher flows during the winter and early spring, while lower concentrations occur at lower flows during the summer. The highest coliform bacteria concentrations at Point-of-Rocks occur during the high flows of winter and spring (mean of 9,000/100 ml for January - June for three years), while the lowest coliform bacteria concentrations occur during the low flows of summer and early fall (mean of 2,300/100 ml for July - October for three years). This relationship between coliform bacteria concentration and stream discharge is under special study by the Interstate Commission on the Potomac River Basin. The washing of pastures and barnyards by heavy rainfall is suspected as a source of the high concentrations.

Antietam Creek, upstream from Hagerstown, may be classified as INCOPOT Class C and MDWR Class B because of monthly mean coliform bacteria concentrations above 5,000/100 ml. Antietam Creek downstream from Hagerstown may be classified as INCOPOT Class D and MDWR Class C because of average dissolved oxygen concentrations below 4.0 mg/l. Even though current water quality data are not available for the Potomac River between Antietam Creek and the Shenandoah River, the classifications may be assumed to be the same as those for the sub-reach immediately upstream (discussed in the previous section); i.e., INCOPOT Class D and MDWR Class B. The Potomac River between the Shenandoah River and the Monocacy River may be classified as INCOPOT Class D because of average B.O.D. concentrations above 3.0 mg/l, coliform bacteria concentrations greater than 5,000/100 ml, and the presence of taste and odor producing substances, and MDWR Class C because of monthly average B.O.D. concentrations over 6.0 mg/l, coliform bacteria concentrations over 10,000/100 ml, and the presence of taste and odor producing substances. In the absence of current water quality data for Catoctin Creek, it can be classified as INCOPOT Class D and MDWR Class B because of coliform bacteria concentrations over 5,000/100 ml found in 1958.

### Monocacy River to Little Falls (37.4 miles)

The Monocacy River enters the Potomac River at River Mile 153.5 and has an average stream discharge (886 cfs over 34 years, as measured near Frederick, Maryland) of about 10 per cent of that of the Potomac River upstream (9,215 cfs over 68 years at Point-of-Rocks, Maryland). Rock Creek joins Marsh Creek at the Pennsylvania State line to form the Monocacy River at River Mile 52.5. Results of six samples from Rock Creek, taken in September and October of 1958, indicate an average B.O.D. of 4.6 mg/l, an average alkalinity of 122 mg/l, hardness of about 125 mg/l, and a mean coliform bacteria concentration of 2,900/100 ml. Dissolved oxygen concentrations averaged 4.5 mg/l, with a minimum of 1.5 mg/l found on one occasion. Waste effluents discharged to the Monocacy River drainage area in Pennsylvania are 750,000 gpd from 10,000 persons, after secondary treatment, at Gettysburg; 160,000 gpd from 2,800 persons, after secondary treatment, at Littlestown;

and 108,000 gpd of inorganic wastes from the Funkhouser Company, after settling in lagoons. The results from other sampling in the Monocacy River drainage area in 1958 are generally not applicable at present because of changes in waste treatment and populations, except for hardness, which was about 100 mg/l in stream reaches downstream from the State line, and alkalinity was 80 mg/l. The headwaters of several tributaries of the Monocacy River serve as water supplies for several communities and receive only chlorination. Piney Creek, which enters the Monocacy River at River Mile 45.3, receives about 150,000 gpd of sewage effluent from 1,500 persons, after secondary treatment, from Taneytown, Maryland; 22,000 gpd of cooling water from Cambridge Rubber Company; and 10,000 gpd of cooling water from A. W. Feeser and Company, both at Taneytown. The loading from the City of Taneytown is estimated to be 38 pounds of B.O.D. per day. The Toms Creek drainage basin, which drains to the Monocacy River at River Mile 43.9, receives 35,000 gpd of sewage effluent from 200 persons, after secondary treatment, at the Victor Cullen State Hospital, Sabillasville, Maryland; 250,000 gpd from 2,600 persons, after secondary treatment, at Emmitsburg, Maryland; 50,000 gpd from 600 persons, after treatment by waste stabilization lagoon following primary treatment, at Mount St. Mary's College at Emmitsburg; and 70,000 gpd from 900 persons, after primary treatment, at Mount St. Joseph's Academy at Emmitsburg. The total organic waste discharge to the Toms Creek drainage area is estimated to be about 200 pounds of B.O.D. per day. The Double Pipe Creek drainage basin, which enters the Monocacy River at River Mile 38.3, receives 40,000 gpd of milk-processing wastes from the Willow Farms Dairy; about 750,000 gpd of sewage effluent from 8,000 persons, after secondary treatment, at Westminster, Maryland; 20,000 gpd of steam condensate from the distillation of wormseed oil at the George W. Magin Company; 55,000 gpd of sewage effluent from 700 persons, after secondary treatment, at New Windsor, Maryland; and 65,000 gpd from 800 persons, after treatment by waste stabilization lagoon, at Union Bridge, Maryland. The total organic waste loading to the Double Pipe Creek drainage area is estimated to be about 250 pounds of B.O.D. per day.

The Maryland State Department of Health sampled the Monocacy River for four days in September 1964. At River Mile 32.9, which is 5.4 miles downstream from Double Pipe Creek, the B.O.D. averaged 1.4 mg/l. The dissolved oxygen concentration averaged 8.6 mg/l, with a minimum of 8.0 mg/l, and the mean coliform bacteria concentration was 850/100 ml. Hunting Creek, which enters the Monocacy River at River Mile 31.6, or its tributaries, receive 55,000 gpd of sewage effluent from 675 persons, after secondary treatment, at Thurmont, Maryland; 18,000 gpd of meat-packing wastes, after primary treatment, from Howard Late and Company at Thurmont; and 9,000 gpd of meat-packing wastes, after treatment by waste stabilization lagoon, from Fraley's Meats at Catoctin Furnace, Maryland. The total waste loading to the Hunting Creek drainage area is estimated to be 150 pounds of B.O.D. per day. The results of four samples taken in September 1964, by the Maryland State Department of Health, from the Monocacy River at River Mile 28.2 (3.4 miles downstream from Hunting Creek) indicated an average B.O.D. of 1.0 mg/l, an average dissolved oxygen concentration of 8.8 mg/l, and a mean coliform bacteria concentration of 750/100 ml. Thus, even with the added waste loading from Hunting Creek, the dissolved oxygen concentration remained high, and the B.O.D. and coliform bacteria concentrations decreased from values found at the upstream sampling station. A slope of about 4.0 feet per mile aids in the self-purification of this stream. The slope downstream from this point decreases to 2.2 feet per mile. During the same survey, the dissolved oxygen content of the Monocacy River increased to an average of 8.9 mg/l at River Mile 25.2 and to an average of 10.2 mg/l at River Mile 22.4, while the B.O.D. concentration increased to an average of about 1.3 mg/l at these two stations. The mean coliform bacteria concentration decreased to 340/100 ml at River Mile 25.2 and increased to 880/100 ml at River Mile 22.4. The increase in coliform concentration at River Mile 22.4 is attributed to waste discharges from individual and small sewerage systems at Walkersville, Maryland (estimated to be 85,000 gpd from 680 persons), and other small communities in the vicinity.

Frederick, Maryland, and Fort Detrick, Maryland, obtain water supplies from the Monocacy River at River Mile 20.4. Taste and odor control are practiced at each treatment facility. A sample of raw water from the Frederick supply, taken by the Maryland State Department of Health in July 1962, contained 88 mg/l hardness, 73 mg/l alkalinity, 144 mg/l total dissolved solids, 9.3 mg/l chlorides, 2.0 mg/l nitrates, 0.2 mg/l iron, and had a turbidity of 10 units, color of 18 units, and a pH of 8.2. Ideal Farms Dairy discharges 4,000 gpd of cooling water to Detrick Creek, which enters the Monocacy River at River Mile 20.1. Fort Detrick discharges 650,000 gpd of sewage effluent after secondary treatment to the Monocacy River at River Mile 19.7. Waste discharges from Fort Detrick average 15 pounds of B.O.D. per day, indicating a high degree of treatment (about 95 per cent removal).

Carroll Creek, which flows through the City of Frederick and enters the Monocacy River at River Mile 18.8, receives 94,000 gpd of neutralized plating wastes from the Everedy Company; an unknown quantity of cooling waters from Jenkins Brothers; unknown quantities of cooling water from the Corning Packaging Company; and an unknown quantity of condenser cooling water from Fort Detrick. A survey of Carroll Creek in 1961 by the Maryland Water Pollution Control Commission indicated the dissolved oxygen content to be high both in the winter (range of 10.1 to 12.3 mg/1) and in the summer (range of 8.6 to 14.0 mg/1). Obviously, photosynthesis brought about supersaturated dissolved oxygen conditions at times during the summer. The B.O.D. ranged from 0.6 to 5.4 mg/1. Large quantities of trash and refuse in the Creek were reported. The Monocacy River at Jug Bridge near Frederick has a very high average annual sediment discharge of 327 tons per square mile, or 267,000 tons per year.

The City of Frederick discharges 3.8 mgd of secondary sewage effluent from 24,500 persons to the Monocacy River at River Mile 18.7. The wastes treated at the sewage treatment plant include dairy, poultry, meat-packing, and cannery wastes. Even with a high degree of treatment (average of about 90 per cent), the waste loading after treatment during the canning season in September 1964, was found to be 1,200 pounds of B.O.D. per day. The Maryland Cooperative Milk Producers discharges 2,000 gpd of wastes from its milk receiving station at Unionville, Maryland, to the North Fork of Linganore Creek. Linganore Creek enters the Monocacy River at River Mile 16.3. The Maryland State Department of Health survey in September 1964 found the following average concentrations in the Monocacy River at River Mile 15.6 (3.1 miles downstream of the Frederick effluent outfall): dissolved oxygen of 1.0 mg/1 (minimum of 0.1 mg/1), B.O.D. of 3.4 mg/1 (maximum of 4.5 mg/1), and coliform bacteria of 2,400,000/100 ml. The average dissolved oxygen concentration increased rapidly to 6.8 mg/1 at River Mile 12.9 and was found to be 8.5 mg/1 at River Mile 1.8. The B.O.D. decreased to an average of 2.2 mg/1 at River Mile 1.8, and the coliform bacteria decreased to 830/100 ml at that point. Examination of three years of data from the Interstate Commission on the Potomac River Basin network station near the mouth of the Monocacy River shows that the monthly average dissolved oxygen content at that point ranged from 6.4 mg/1 in August to 12.3 mg/1 in February. The average B.O.D. concentration ranged from 1.2 mg/1 in September to 4.6 mg/1 in February, and the mean coliform bacteria concentration ranged from 1,300/100 ml in September to 36,000/100 ml in March.

The Potomac Electric Power Company obtains an average of 355 mgd and a maximum of 415 mgd from the Potomac River at River Mile 152.4 for the Dickerson Generating Station in Maryland, and discharges the heated waters after use at River Mile 152.1.

Sanitary wastes from 81 employees are given secondary treatment before discharge at the same point. The Academy of Natural Sciences of Philadelphia (Pennsylvania) performed extensive biological and chemical surveys of the Potomac River upstream and downstream of the Station in 1956, 1960, and 1961 to determine the effects of the heated waste discharges on the River. These surveys were performed both before and after initial operation (1958) and expansion (1960) of the Station. The 1961 report concludes, "These surveys were carried out in June (High Water) and August (Low Water) and indicated that overall there were no major changes in the aquatic biota that might have been caused by the PEPCO operations." The Potomac River was rated as "healthy" with respect to all biological types at all sampling stations during each of the three survey periods. Examination of the temperature data reveals that the warmer waters of the Shenandoah River do not mix readily with the cooler waters of the Potomac River during higher stream discharges. At 6:00 a.m. in June, at Point-of-Rocks, Maryland (River Mile 159.5), the water temperature on the right (Virginia) bank was 1.8° to 5.6°F. higher than on the left (Maryland) bank, though this differential decreased to 0.7° to 1.8°F. by 6:00 p.m. During low stream discharges, the difference in temperatures between banks at Point-of-Rocks was insignificant. Immediately below the Generating Station, the water temperature on the left bank at 6:00 a.m. averaged 80.8°F. for the four sampling days in June (high stream discharges), while the corresponding temperatures on the right bank averaged 75.4°F., the differential of 5.4°F. being caused by the Station's discharge. The maximum water temperatures in June at the Station were reached at 3:00 p.m., being 82.0°F. on the left bank (Station side) and 77.4°F. on the right bank, a differential of 4.6°F. In August (low stream discharge), the 6:00 a.m. temperatures immediately below the Station averaged 85.8°F. on the left bank and 78.4°F. on the right bank, a differential of 7.4°F., while the 3:00 p.m. temperatures averaged 92.1°F. on the left bank and 83.1°F. on the right bank, a differential of 9.0°F. Dissolved oxygen concentrations were decreased by the elevated temperatures, but no dissolved oxygen concentrations below 6.0 mg/l were found. Total hardness measured at the Generating Station in 1961 averaged 115 mg/l in June and 137 mg/l in August; the alkalinity averaged 79 mg/l in June and 99 mg/l in August; the B.O.D. of one sample in June was 2.5 mg/l and of one sample in August was 6.0 mg/l; and the mean coliform bacteria concentration was 540/100 ml in June and 120/100 ml in August. Dissolved iron content was insignificant, phosphate averaged 0.06 mg/l in June and 0.10 mg/l in August; nitrate nitrogen averaged 0.59 mg/l in June and 0.31 mg/l in August; and total of nitrite, nitrate, and ammonia nitrogen averaged 0.69 mg/l in June and 0.39 mg/l in August. The Academy found the water quality of the Potomac River 5.5 miles downstream of the Generating Station (i.e., River Mile 146.6) to be essentially the same as that immediately below the Station, except that the temperatures were lower (roughly 5.0° to 9.0°F. on the left bank) and the dissolved oxygen concentrations were higher by about 0.5 to 4.0 mg/1, with evidence of photosynthetic plants being present at the lower sampling station.

Goose Creek, which enters the Potomac River from Virginia at River Mile 142.1, receives a total of about 240,000 gpd of sewage effluent from about 3,000 persons from Middlesburg, Leesburg, Goose Creek Country Club, and Foxcroft School, all after secondary treatment. Goose Creek has a very high average annual sediment discharge of 290 tons per square mile, or 98,000 tons per year, as measured near Leesburg, Virginia.

Sugarland Creek, which enters the Potomac River from Virginia at River Mile 135.3, receives about 155,000 gpd of sewage effluent from 1,960 persons, after secondary treatment, from Herndon, Virginia. Three years of data from the Interstate Commission network show that the maximum monthly average B.O.D. concentration was 3.2 mg/1 in January, the minimum monthly mean dissolved oxygen concentration was 4.3 mg/1 in September, and the maximum mean monthly coliform bacteria concentration was 89,000/100 ml in August.

Seneca Creek, which enters the Potomac River at River Mile 133.9, or its tributaries, receive about 1,200 gpd of plating wastes after neutralization, oxidation, and settling from Weinschel Engineering Company; 15,000 gpd of milk processing wastes and 10,000 gpd of cooling water from Hadley Farms Dairy at Laytonsville, Maryland. The maximum monthly average B.O.D. concentration of Seneca Creek for three years was 3.3 mg/1 in February, the minimum monthly average dissolved oxygen concentration was 7.4 mg/1 in June, and the maximum monthly mean coliform bacteria concentration was 9,900/100 ml in June. Seneca Creek has a very high average annual sediment discharge of 320 tons per square mile, or 32,300 tons per year, as measured at Dawsonville, Maryland.

Watts Branch, which enters the Potomac River at River Mile 129.2 has an unusually high average annual sediment discharge of 516 tons per square mile, or 1,910 tons per year.

Difficult Run, which enters the Potomac River from Virginia at River Mile 124.1, also has a high average annual sediment discharge of 290 tons per square mile, or 16,200 tons per year.

The Washington Suburban Sanitary Commission obtains an average of 5.5 mgd from the Potomac River at about River Mile 127.0. The Washington Aqueduct Division, U. S. Army Engineer District, Baltimore, obtains an average of 167 mgd from the Potomac River at Great Falls, Maryland (River Mile 126.5), to supply Washington, D. C. Treatment practices, at times, include taste and odor control.

The Public Health Service maintains a station of the National Water Pollution Surveillance System at Great Falls in cooperation with the Washington Aqueduct Division. The results from five years of weekly sampling have been analyzed and are summarized in Appendix IV. That analysis shows that the monthly average dissolved oxygen concentration reached a minimum of 5.9 mg/l in July, when a minimum individual value of 3.0 mg/l occurred. The monthly average B.O.D. reached a maximum concentration (3.3 mg/l) in February, with a maximum individual concentration value of 8.6 mg/l. The maximum monthly mean coliform bacteria concentration of 3,900/100 ml occurred in March. While this coliform concentration was determined from weekly sampling for a period of five years, daily sampling for four years (within the above five-year period) by the Washington Aqueduct Division resulted in a monthly mean of 8,200/100 ml for March. That Division attributes the difference in results to the "flashy" nature of the Potomac River, so that weekly sampling may miss many high bacterial counts at high stream flows of short duration. The fact that the highest concentrations of B.O.D. and coliform bacteria occur at times of highest stream discharge suggests that surface drainage is a principal source. Calculations of the Interstate Commission on the Potomac River Basin show that the coliform bacteria counts exceed 2,000/100 ml at least some portion of every month and up to about 95 per cent of the time during some months, the high values occurring principally in the winter (high stream flow) months. The monthly average water temperatures at Great Falls ranged from 34.7°F. in January to 78.6°F. in July, with a maximum individual value of 91.9°F. (occurring in July). The maximum monthly average hardness of 141 mg/l occurred in October (at lowest flows) with a maximum individual value of 188 mg/l occurring in August; the annual average hardness was 105 mg/l. The maximum individual determination of gross beta radioactivity of 213 pc/l (picocuries per liter), the maximum monthly average of 55 pc/l (November), and the annual average of 23 pc/l, are well under the maximum permissible concentration of 1,000 pc/l for mixtures of unknown radionuclides in the absence of alpha emitters and Strontium 90. The maximum soluble phosphate phosphorus concentration of 0.3 mg/l occurred in April. A special study of chlorinated hydrocarbon pesticides was made on September 23, 1964, as part of the National Water

Pollution Surveillance System. At Great Falls, the Potomac River had a concentration of Dieldrin between 0.040 µg/l (micrograms per liter) and 0.08 µg/l and a concentration of Endrin between 0.094 µg/l and 0.188 µg/l, the latter being the highest concentration found at any of the stations located throughout the Nation. (These values are similar in magnitude to those found in the lower Mississippi River during the major fish kill of 1964, except that the concentrations in the Potomac River were apparently of short duration.) Water of the Potomac River at Great Falls is generally moderately hard, and at times contains tastes and odors.

The U. S. Navy Bureau of Ships discharges about 130,000 gpd of secondary sewage effluent from about 1,600 persons at the David Taylor Model Basin, Carderock, Maryland, to the Potomac River at River Mile 121.7.

Downstream from the vicinity of Cabin John Creek (River Mile 119.0), the sewerage system draining to the District of Columbia Blue Plains Sewage Treatment Plant (now called the District of Columbia Water Pollution Control Plant) contains combined sewers which transport both sanitary sewage and storm drainage. These sewers overflow during intensive rain storms, thus allowing untreated sewage to enter the Potomac River. An extensive program is underway to provide separate sewers throughout the entire sewerage system.

Little Falls Branch, which enters the Potomac River at River Mile 116.3 just upstream of the District of Columbia boundary line, receives about 10,000 gpd of settled concrete truck washing wastes from Maloney Concrete Company and occasional discharges of oil-drum cleaning and oil spillage wastes from the Washington Petroleum Company, both in the Chevy Chase area of Maryland. Little Falls Branch has an extremely high average annual sediment discharge of 2,320 tons per square mile, or 9,530 tons per year, as measured near Bethesda, Maryland.

During low stream discharge periods, the Washington Aqueduct Division obtains a portion of the water supply for Washington, D. C., just above Little Falls at River Mile 116.3. The Dalecarlia Water Filtration Plant of the Washington Aqueduct Division discharges an average of 1.8 mgd of filter wash water plus wastes from washing settling basins (discharged at high stream flows) to the Potomac River below Little Falls. These wastes contain all of the silt removed from the raw water, plus coagulating chemicals, principally alum. The maximum wash water use occurs during the summer, with the peak usage occurring in August. The average wash water use over the past five years was 2.2 mgd, or about 1.3 per cent of the total raw water intake volume (for two filtration plants).

## IV. POTOMAC RIVER ESTUARY

| | |
|---|---|
| Upstream River Mile . . . . . . . . . . . | 116.1 |
| Downstream River Mile . . . . . . . . . . | 0.0 |
| Length of Estuary . . . . . . . . . . . . | 116.1 miles |
| Area Draining Directly to Estuary . . . . | 3,090 square miles |
| Total Drainage Area to Potomac River Basin . . . . . . . . . . . . . . | 14,670 square miles |

### Summary

Waste effluents discharged in the metropolitan area of the District of Columbia significantly reduce water quality in the upper Potomac River estuary over a distance of approximately 40 miles from the vicinity of the 14th Street Bridge in the District of Columbia to Sandy Point. Deleterious effects attributable to these wastes include very high bacterial levels, high concentrations of organic materials, a low and sometimes depleted dissolved oxygen content, and high nutrient concentrations which bring about massive algal blooms. The algal blooms discolor the water, reduce its clarity, and in general create a displeasing aesthetic appearance. The subsequent death, sedimentation, and decay of these organisms may contribute further to the unsatisfactory oxygen conditions in the upper estuary. Low dissolved oxygen levels may be a predisposing, if not primary, factor in some of the fish kills which are repeatedly observed in the Potomac. Suspended sediment entering at the head of the estuary from the Potomac River, from surface runoff in the D. C. metropolitan area, and from sand and gravel operations, contribute to the turbidity of the upper estuary.

In the lower estuary from U. S. Highway 301 Bridge to the mouth, water quality is generally satisfactory for most uses; however, occasional algal blooms and fish kills do occur. In addition, there are a few small isolated areas below waste outfalls where coliform bacteria concentrations are such as to prevent the commercial harvesting of shellfish. Depleted oxygen conditions in the deep waters near the mouth of the Potomac are observed annually during the warmest months of the year. This condition is common to all deep waters of the Chesapeake Bay and its tributary estuaries.

The water quality objectives set for the estuary from Little Falls to Hallowing Point by the Interstate Commission on the Potomac River Basin are not being met in all respects at the present time (1965).

A map of the Potomac River estuary is presented in Figure 15.

Little Falls to U. S. Highway 301 Bridge (67.3 miles)

The quality of estuarial waters is predominantly influenced by the quality of the fresh water inflow at its head and the brackish or salt water body at its mouth. In addition, tributary streams, ground water, and waste water discharges entering the estuary along its length affect the water quality.

The principal fresh water inflow to the Potomac estuary is provided by the Potomac River. The River, upon entering the area of tidal influence just below Little Falls, 116.1 miles above Chesapeake Bay, has drained about 11,500 square miles, or about 80 per cent of the total area draining to the tidal estuary. The River provides roughly 80 per cent of the total fresh water inflow, since ground-water accretions to the estuary are not considered to be significant.

Minor tributary streams having relatively small drainage basins enter the estuary all along its length. Two of these, Rock Creek and Anacostia River, enter near the head of the estuary and drain major portions of the District of Columbia Metropolitan Area. All of these tributaries are important to the estuary, but more from the standpoint of quality than quantity.

Rock Creek, which enters the Potomac River estuary in the District of Columbia at River Mile 111.9, receives untreated sewage when combined sewers overflow during storms. Also, the District of Columbia West Heating Plant discharges 225,000 gpd of cooling water and 225,000 gpd of boiler blowdown and water softener backwash to Rock Creek. Minor quantities of oil from spillage at two establishments are discharged to tributaries. Because of the storm-water overflows, the water quality in Rock Creek is highly variable. Monthly mean B.O.D. values at the mouth average 4.4 mg/l during December through May, and 2.8 mg/l during June through November, reflecting high storm-water flows in the winter and spring. Monthly mean coliform bacteria counts at the mouth vary from 110 to 130,000/100 ml, showing no distinct seasonal pattern. Monthly mean dissolved oxygen concentrations at the mouth average 8.9 mg/l during June through November, with no monthly mean below 7.0 mg/l. The quality of water upstream in Rock Creek for nine miles is essentially the same as at the mouth, although B.O.D. and coliform concentrations are slightly lower upstream. The quality of the Potomac River estuary adjacent to the confluence with Rock Creek is generally better than that in Rock Creek, indicating that the lower water quality in Rock Creek is the result of the storm-water overflows from combined sewers in the drainage area, and not due to tidal exchange with the Potomac estuary. The average annual sediment discharge of Rock Creek at Sherrill Drive, Washington, D. C., is 1,600 tons per square mile, or 99,500 tons per year.

The Anacostia River, which enters the Potomac River estuary in the District of Columbia at River Mile 107.8, is influenced for about four miles by tidal exchange with the main estuary. Significant concentrations of sewage effluent from the District of Columbia Blue Plains Sewage Treatment Plant have been traced by dye throughout the lower four miles of the Anacostia River. Untreated sewage from combined sewers overflowing during storms discharges directly to the Anacostia River. Other discharges to the River or its tributaries include 264 mgd of cooling water from two electric generating stations, wash water from sand and gravel washing operations, 110,000 gpd of sanitary waste effluent, after primary treatment, and 160,000 gpd of cooling water from the Naval Ordnance Laboratory, and other wastes of lesser significance. The quality of water in the Anacostia River is highly variable. Monthly mean coliform counts in the lower seven miles have ranged from 500 to 4,880,000/100 ml, the higher values generally occurring December through May, but with high and low values being found throughout the year. Monthly mean B.O.D. values range from 0.9 to 17.2 mg/l, being generally higher upstream during December through May, and generally higher downstream from June through November. Monthly mean dissolved oxygen concentrations near zero may be found at times beginning two miles above the mouth and extending upstream for two or more miles, but concentrations are generally above 5.0 mg/l near the mouth throughout the year. The average annual sediment discharge of the Northeast Branch Anacostia River at Riverdale, Maryland, is 1,060 tons per square mile, or 77,400 tons per year; of the Northwest Branch Anacostia River near Colesville, Maryland, is 470 tons per square mile, or 10,000 tons per year; of the Northwest Branch Anacostia River near Hyattsville, Maryland, is 1,850 tons per square mile, or 91,300 tons per year.

The quality of the Potomac River at Great Falls, summarized in Appendix IV, may be considered representative of the fresh water contribution to the estuary. By considering its chloride content, which is quite low as compared to that found at the mouth in Chesapeake Bay, some idea may be gained of the distribution along the estuary of the soluble constituents contributed by both sources.

Mineral Salts. It is generally recognized that the chloride content of the estuary will gradually increase from a minimum value at the head to a maximum value at the mouth. This is also true of other constituents such as alkalinity, sodium, potassium, and others which are present in much higher concentrations in the sea than in rivers. Chlorides, however, are usually of greater significance to most water uses.

The chloride content of the Potomac River at Great Falls varies from 3.0 to 30 mg/l, while that of the Chesapeake Bay at the mouth of the Potomac River varies from about 5,000 to 10,000 mg/l. The chloride content within the estuary will lie between these extremes, the actual value being dependent upon location in the estuary and seasonal differences in fresh water inflow rates. The chlorides of the Bay waters move up the estuary by a process usually referred to as turbulent diffusion, which is brought about by the action of reversing tidal currents. The chlorides contributed by the Potomac River move downstream by the same process and, in addition, are displaced seaward by the river discharge which flows through the estuary to the Bay. This latter process is referred to as advection.

As would be expected, the chloride concentration in the upper estuary varies inversely with the river inflow. At the Public Health Service automatic water quality monitor on Memorial Bridge at Washington, D. C., the chloride concentration between July 1963 and December 1964 varied from a low of 5.0 mg/l during the winter, to a high of 50 mg/l during the late autumn of 1964. This latter value is almost twice the maximum chloride concentration found at Great Falls and reflects the presence of sea salts which have diffused upward from the Bay. At the U. S. Highway 301 Bridge (River Mile 40.3), the low spring chloride content is usually greater than 1,500 mg/l, while the late fall maximum concentration will generally reach 6,000 mg/l.

During the four-year period of 1961 - 1964, chloride concentrations of 250 mg/l reached approximately 86, 90, 98, and 90 miles above the River mouth in successive years, the maximum upward intrusion taking place in the late fall. The maximum intrusion occurred in November of 1963, when chlorides of 192 and 359 mg/l were observed at Fort Foote (River Mile 101.7) and Fort Washington (River Mile 97.8), respectively. This extensive upstream intrusion of sea salts can be attributed to the very low Potomac River flows experienced during that year and was comparable to the intrusion found during the 1930 drought. In that year, the chloride level at Indian Head (River Mile 86.3) reached a maximum value of just over 3,000 mg/l, while in 1963, a maximum of 2,650 mg/l was observed at Possum Point (River Mile 78.5). The total Potomac River flow (at Point-of-Rocks, Maryland) in 1930 was 4.7 million acre-feet, while in 1963, 5.1 million acre-feet were discharged at this Potomac River gage. It is doubtful that chloride concentrations in excess of 250 mg/l would ever be found very far upstream of Fort Foote, unless droughts were more severe than those experienced over the last 70 years. The 250 mg/l chloride level is significant, since this is the recommended maximum concentration for drinking water supplies (Public Health Service Drinking Water Standards).

Should the Potomac River Basin flows above the estuary become more regulated as the result of dam construction, minimum drought flows to the estuary will be increased, and the upstream intrusion of sea salts will be inhibited. On the other hand, if any significant quantity of Potomac River water is not returned to the upper estuary after use, a further intrusion of salts would be expected.

The variations in chlorides described above apply also to total dissolved solids, hardness, and sulfates. During periods of low fresh water inflow, the total dissolved solids content of the Potomac River at Memorial Bridge falls between 200 to 300 mg/l, the hardness between 150 to 200 mg/l, and sulfates in the range from 75 to 100 mg/l. When the Potomac River flows are high, these concentrations drop to ranges of 140 to 200 mg/l for total dissolved solids, 80 to 135 mg/l for hardness, and 25 to 50 mg/l for sulfates. The lowest concentrations cited are comparable to those found in the Potomac River at Great Falls at times of maximum flow, while the highest values are all higher than those encountered at Great Falls and reflect the presence of sea salts just as in the case of chlorides. As one moves down the estuary, each of these quality indicators increases in a manner similar to the increases described for chlorides.

Temperature. Water temperatures in the upper estuary reflect ambient conditions, being highest in July and lowest in January. The five-year mean (1960 - 1964) surface temperatures at Memorial Bridge for the above months were 82° and 36°F., respectively. Maximum values in the mid-nineties may be found in shallow waters at sunset during the summer. These temperatures are typical of the entire upper estuary down to the U. S. Highway 301 Bridge. At depths below 30 feet in the saline portions of the upper estuary, water temperatures are usually 2.0° to 3.0°F. cooler.

Sediment and Water Transparency. A considerable sediment load, estimated to be approximately 2.5 million tons annually, is transported to the estuary by tributary streams. Much of this load is delivered to the head of tide by the Potomac River; however, significant amounts also enter from the smaller tributaries which drain the Washington Metropolitan Area. This silt contributes to the turbidity of the tidal estuary before settling to the bottom. Since 90 per cent of the upstream load enters during that 10 per cent of the time when stream flows are highest, maximum turbidity levels would be expected during the same period of the year; i.e., late winter and spring. Any intense local rainstorm in the Washington Metropolitan Area will produce a heavy silt load which causes very high turbidities in the estuary at and near Washington. This silt gives the water an obvious brown color, which rapidly dissipates as the suspended material settles out.

The average turbidity of the Potomac River during the four-year period from 1961 - 1964 is shown in Figure 1. The average turbidity in the upper five miles of the estuary and that observed near Maryland Point, 50 miles downstream, are both relatively low, being less than 40 J.C.U.* Everywhere in the 50-mile reach between these two limits, the turbidity is higher. Two turbidity peaks may be readily identified. A rather sharp peak (51 J.C.U.), occurring near the Blue Plains outfall, is attributed to the discharge of sewage treatment plant effluent containing suspended solids. After the peak at the sewage treatment plant, a more gradual build-up in turbidity is observed, reaching a maximum of 54 J.C.U. at Hallowing Point. This turbidity build-up is similar to the B.O.D. build-up in the estuary (discussed in a later section). Both B.O.D. and turbidity reach a peak at Hallowing Point, 15 miles below the Blue Plains outfall, and are assumed to derive from the same cause; i.e., algal cells. This assumption is supported by recent findings of the Chesapeake Bay Institute, which is carrying out algae and nutrient studies in the Potomac estuary for the Public Health Service. For these studies, maximum chlorophyll levels, indicative of maximum algal density, have been consistently found at stations near Hallowing Point. Thus, while the direct effect of the Blue Plains effluent in increasing turbidity is quite noticeable, the indirect effects caused by the stimulation of algal growths reach even higher levels and affect a much greater section of the estuary.

A large (400 tons per hour) sand and gravel dredging operation is carried out on Greenway Flats just below Hallowing Point.

---

* Jackson Candle Units

Studies by the Maryland Department of Water Resources show that a great deal of turbidity is created in the immediate vicinity of the dredging and washing operations. These effects are confined, however, and are not noticeable beyond a distance of about 1,000 feet.

The Potomac River at Great Falls had an average turbidity of 40 J.C.U. for 252 samples collected over a recent five-year period. This is quite comparable to the estuary outside of the area influenced by waste discharges. The Potomac estuary also compares favorably with another heavily populated East Coast estuary, the Delaware at Philadelphia, where the average of 53 readings during the 1962 water year was 80 J.C.U.

Turbidity or resistance to light penetration into the water may also be measured by means of the Secchi disk or photometer cells. Equivalent Secchi disk readings, or the depths at which approximately 16 per cent of the incident light remains, were recorded during the period from March to September of 1965. In the navigation channel of the upper estuary below Giesboro Point, Secchi disk readings varied from 1.5 to 5.0 feet. The lowest values, 1.5 to 2.5 feet, were found between Giesboro Point (River Mile 107.4) and Indian Head (River Mile 86.5); values in this area were usually higher in the spring than in the summer. Between Indian Head and U. S. Highway 301 Bridge, somewhat higher readings were obtained, ranging from 2 to 5 feet. In this reach, however, the higher readings were obtained in August and September. It appears that in the spring the upper estuary is uniformly turbid as a result of spring runoff. In the summer, the lower portion becomes clearer as the silt load is reduced, while algal growths in the upper portion restrict light penetration even further than the light restriction experienced in the spring.

Nutrients. Heavy algal growths which give a bright green color to the water are observed throughout the upper estuary during the warmest months of the year. These growths are known to be stimulated by the fertilizing materials contained in waste effluents, primarily nitrogen and phosphorus. During August and September of 1965, when algal growths were particularly heavy, about 15 tons of inorganic nitrogen were added to the estuary each day in waste effluents, in addition to about 3.0 tons per day which entered in the Potomac River inflow. Most of the nitrogen was in the form of ammonia, with a peak concentration of over 3.0 mg/l being observed near the Blue Plains Sewage Treatment Plant outfall. Much of the ammonia was subsequently converted by bacterial oxidation to the nitrate form, which reached a concentration of over 1.0 mg/l about 10 miles below the Blue Plains outfall. Extremely high phosphorus concentrations were also present, 0.9 mg/l being observed near Fort Washington.

In a study of the Potomac River in the Washington Metropolitan Area (1959), the total phosphorus content of the River just above the tidal reach was found to be 0.23 mg/l, and the content in the tidal area several miles below the municipal sewage effluent outfall was found to be greater than 1.0 mg/l. Based on measurements made in 1965, it is estimated that approximately eight tons per day of phosphorus are discharged to the estuary in waste effluents. These nutrient materials are present in sufficient quantity to support massive algal growths in the estuary. Chlorophyll levels, which are indicative of algal density, were found in 1965 to have reached a maximum of 180 µg/l in the estuary. This level is higher than previously reported anywhere in the Chesapeake Bay tidal system.

Influence of Waste-Water Discharges. The Potomac River estuary and its minor tributaries receive waste-water discharges from the Washington Metropolitan Area, several communities and Federal installations below Washington, power generating stations, and several industries, principally sand and gravel washing operations. The principal organic waste loadings occur in the Washington Metropolitan Area and include the District of Columbia Blue Plains Sewage Treatment Plant (80,300 lbs/day B.O.D.), Arlington County (23,000 lbs/day B.O.D.), and Fairfax County (12,500 lbs/day B.O.D.). A complete listing of waste discharges giving location and treatment provided is presented in Appendix V.

The Blue Plains Sewage Treatment Plant outfall, which is the principal waste source, enters the estuary at River Mile 105.4. Upon leaving the outfall pipe, which lies on the bottom and terminates at the eastern edge of the deep water channel, this waste stream rises to the surface, becoming slightly diluted by the surrounding waters which are entrained in the waste plume. The turbulence of the moving tidal waters bring about favorable mixing conditions, with the wastes being transported over several miles upstream or downstream depending on whether the tide is flooding or ebbing. To a large extent, the water mass containing the waste is returned to the vicinity of the outfall by the reversing tidal current. However, in traversing the distance of the tidal excursion, the waste material is mixed throughout a larger water mass by turbulent diffusion processes, resulting in lower waste concentrations on returning to the point of discharge.

An idealized pattern of dispersion of a waste discharge to a uniform tidal channel having no inflow may be envisioned by considering the incremental discharge at the time of slack water. A plot of waste concentration versus distance longitudinally along the estuary would, at the time of discharge, show an extremely high concentration at the discharge point, with no waste present at short distances upstream or downstream. After one complete tidal cycle, such a plot would show the peak concentration remaining at the point of discharge, though greatly reduced in magnitude, with a normal distribution of waste both upstream and downstream for a total distance approaching the tidal excursion distance. With succeeding tidal cycles, the normal distribution of waste concentration would remain about the discharge point but with a diminishing peak concentration. From this peak value, the concentration decreases in both upstream and downstream directions for large distances. Ultimately this curve would flatten out to a straight line, indicating uniformly infinitesimal concentrations throughout the system. Under the more practical conditions of the Potomac estuary with stream flow entering at the head, the channel cross-section increasing toward the mouth, and a net outflow to the ocean causing a net outflow displacement seaward through the estuary, the normal distribution mentioned above would be skewed toward the Bay, and the peak concentration, instead of remaining in the vicinity of the outfall, would have a net movement seaward with time.

In the usual case of a steady discharge, such as that from a waste treatment plant, the peak concentration in the estuary would lie downstream from the discharge point at low slack water and above the discharge at high slack water. If averaged over a tidal cycle, the peak concentration would be found at the outfall. Both the magnitude of the peak concentration and the extent of the upstream intrusion of the waste would be limited by the fresh water inflow entering at the head of the estuary. In the case of non-conservative pollutants, increasing stream flows to the estuary would result in an increase in downstream pollutant concentrations.

Oxygen Balance. The presence of organic waste discharges to the Potomac River may be detected by increased B.O.D. concentrations and the resulting depressed dissolved oxygen conditions, which these waste materials bring about in the estuary.

Samples collected at five stations located at about one-mile intervals above the 14th Street Bridge from June to November show the B.O.D. to be quite uniform. The B.O.D. level exceeded 10 per cent of the time in this area is near 3.5 mg/l. Below the 14th Street Bridge, the B.O.D. concentration rises rapidly over the next four miles, reaching a maxumum just below the Blue Plains outfall where the level exceeded 10 per cent of the time is 12.0 mg/l. The B.O.D. concentration drops very slowly and at a distance of 40 miles below the peak concentration has not returned to the levels found above the 14th Street Bridge. The upper 10 per cent of the concentrations found at Maryland Point (River Mile 61.0) exceed 4.3 mg/l.

An attempt to balance the incoming B.O.D. waste loadings with the total B.O.D. found in the estuary has shown more than ten times the calculated value to be present. This apparent production of secondary B.O.D. in the estuary begins above the Blue Plains outfall and reaches a peak some 15 miles below the outfall, after which it begins to drop off. It may be presumed that this discrepancy is partially attributable to algal cells which are contained in the samples collected in the estuary but are not present in the waste-water effluent samples.

Dissolved oxygen concentrations in the estuary drop steadily from the head of **tide** to a minimum at the Blue Plains outfall, as shown in Figure 2. In the critical two-month period from July 15 to September 15, the lowest 10 per cent of the values observed over five years were below 6.7 mg/l at River Mile 114.8, dropping to 1.4 mg/l at the Blue Plains outfall. Proceeding downstream, dissolved oxygen concentrations rise steadily, and at Sandy Point (River Mile 75.0), the lower 10 per cent of the values lie below 6.5 mg/l, similar to conditions found some 40 miles upstream. The recovery of the dissolved oxygen curve is impeded by the increasing salinity and resulting decreased solubility of oxygen encountered downstream of the Washington Metropolitan Area.

From the above, it is evident that the estuary oxygen balance is affected by Metropolitan Area waste discharges over a distance of about 40 miles. These effects are most serious in a 10-mile reach **extending** from Giesboro Point (River Mile 107.4) to Fort Washington (River Mile 97.8) where dissolved oxygen concentrations are less than 4.0 mg/l half of the time during the warm summer months. Concentrations between zero and 1.0 mg/l are not infrequent in this stretch. Furthermore, it should be noted that the concentrations discussed above were found in samples collected near the surface of the navigation channel during daylight hours. Nighttime samples collected near the bottom, especially outside the channel, could be as much as 1.0 to 2.0 mg/l lower. This is due to the uptake of oxygen by both the decomposible, organically rich bottom muds and respiring phytoplankton, which may be found in great numbers in the upper estuary during the warmer months.

The trend in critical dissolved oxygen concentrations at six estuary stations measured over the past 10 years is shown in Figures 3 through 8. Little significant improvement in minimum dissolved oxygen concentrations is apparent during that period.

Bacteriological Quality. The number of coliform organisms present in the estuary is markedly influenced by the waste effluents discharged in the Washington Metropolitan Area, primarily by that discharged at Blue Plains. Figures 9 and 10 show the five-year mean of the average monthly concentrations found in the June through November, and December through May periods, respectively. The highest coliform concentrations are encountered in the winter and spring months, considered to be primarily the result of the cessation of chlorination of the Blue Plains effluent. The high fresh water inflows which carry large numbers of coliforms and, in the case of downstream stations, the lower die-off rates experienced in colder weather, and the advective effects of high stream flows on the peak concentration, also contribute to higher bacterial levels during December through May. During the same period, the mean coliform counts above the estuary were 6,800/100 ml at Point-of-Rocks (River Mile 159.4), Maryland, and 3,100/100 ml at Great Falls (River Mile 126.5). Coliform levels in the upper five miles of the estuary above the Memorial Bridge are lower than those in the River at Point-of-Rocks, and it is not until a half-mile below the 14th Street Bridge that the upper River coliform levels are exceeded in the estuary. The mean coliform counts quickly rise in the 4.5 miles below this point and reach a peak of 260,000/100 ml near the Blue Plains outfall. This high level slowly drops over the next 30 miles, until a relatively stable mean value, less than 200/100 ml, is reached. Thus, in the winter and spring months, the mean coliform level in three overlapping reaches of different lengths in the vicinity of the Blue Plains outfall are as follows: in the upper 30 miles of the estuary, mean coliform counts generally exceed 2,000/100 ml; in the 15-mile reach from Potomac Park (River Mile 109.1) to below Marshall Hall (River Mile 93.8), they exceed 10,000/100 ml; and they exceed 50,000/100 ml in a five-mile reach from just below Giesboro Point (River Mile 107.4) to a point below Fort Foote (River Mile 101.7).

In the summer and fall months of the recreational season on the Potomac estuary, the River contributes less inflow and contains fewer coliform organisms. However, coliform concentrations in the estuary above the Blue Plains outfall are as high, or higher, at this time than during the winter, since further upstream intrusion of wastes is possible. Though the Blue Plains effluent is chlorinated, some regrowth of organisms possibly takes place in the estuary. The mean peak concentration at the outfall is less than half the winter-spring value, or 120,000/100 ml. The drop in bacterial numbers is more rapid than in the winter below the plant, and mean concentrations less than 1,000/100 ml are found at Hallowing Point (River Mile 89.5). In the summer-fall season, then, mean coliform concentrations in excess of 2,000/100 ml extend over a 20-mile stretch of the upper estuary above Fort Washington, and values greater than 50,000/100 ml are confined to a four-mile stretch from below Giesboro Point to just above Fort Foote.

Fish Kills. The Potomac estuary has had a long history of large fish kills. One of the more recent of these (1963) was tentatively attributed to a bacterial infection among the white perch. The large kill which occurred in May 1965, however, affected several different fish species, and in this case, bacterial studies yielded negative results. The extent of this kill is shown in Figure 11. Examination of a few of the more than 500,000 fish estimated to have died showed the presence of pesticides. However, these compounds were also found at similar non-lethal levels in fish that were not affected and was not considered to have caused the mass mortality which was observed. A small number of water samples analyzed for dissolved oxygen at that time showed concentrations much lower than would be expected at that time of year, and this condition may have contributed, directly or indirectly, to the fish kill. A definite correlation may not always be established between man-made pollution and fish kills in the Potomac River; however, this possibility can not be completely ruled out.

Water Quality Criteria. The water quality objectives and criteria established for the upper Potomac estuary in 1958 by the Interstate Commission on the Potomac River Basin are given in Appendix I. The objectives and criteria differ for each of three reaches of the estuary.

In the upper reach, from Little Falls (River Mile 116.1) to Key Bridge (River Mile 112.5), the water use objectives are swimming, boating, shore recreation, and propagation of all fish species. The criteria established to meet these objectives are currently not being met with respect to coliform numbers, since levels in excess of the maximum of 2,000/100 ml specified for "nearly all" of the samples are frequently observed. Criteria established for dissolved oxygen are being met in this reach.

In the middle reach, from Key Bridge (River Mile 112.5) to Fort Washington (River Mile 97.8), the water use objectives are boating, shore recreation, industrial water supply, safe passage of all fish, and propagation of the hardier types of fish. Here the criterion for the coliform group is less than 10,000/100 ml in "most" of the samples. This criterion is not met in the reach except for a two-mile stretch at the upper end. The specified monthly average dissolved oxygen of 5.0 mg/l with a minimum of 4.0 mg/l is not met anywhere in the reach during estuary during the warm summer months. Daytime dissolved oxygen concentrations at the surface are generally at or above saturation and, while no nighttime dissolved oxygen values are available, it could be expected that these would be below saturation. In the deeper waters (40 feet and below) at the mouth of the Potomac, complete depletion of oxygen is commonly found from July to September. The pH values in these deep waters are just above 7.0, while at the surface the pH generally exceeds 8.0. These completely deoxygenated conditions are also found below 40 feet throughout the entire central portion of Chesapeake Bay during the summer and can be attributed to oxygen uptake by bottom sediments coupled with a lack of vertical mixing due to a significant degree of vertical density stratification. It is not known how far up the Potomac estuary similar conditions exist, but it may be reasonably assumed that the entire lower estuary is probably devoid of oxygen at water depths greater than 35 to 40 feet during the summer.

Transparency of the water, as measured by Secchi disk readings taken between March and September, varied from 3 to 13 feet. The highest values are found near the Chesapeake Bay in the spring (11-13 feet) and near the Highway 301 Bridge in the summer (7-9 feet). The water is more turbid at the River mouth in summer (7-8 feet) and near the Highway 301 Bridge in the spring (3-5 feet).

The Maryland State Department of Health, as a participant in the certification program of interstate shellfish shippers in cooperation with the Public Health Service and the shellfish industry, has classified the waters of the lower Potomac River estuary and its estuarine tributaries according to Part I of the _Manual of Operations of the Cooperative Program for the Certification of Interstate Shellfish Shippers_, PHS Publication No. 33. Based upon bacteriological sampling and sanitary surveys, the following areas have been classified as "prohibited:" _Neale Sound_ north of Cobb Island (River Mile 38.1); _Breton Bay_ north of a line drawn from Society Hill to Lovers Point (River Mile 27.2); and _St. Mary's River_ upstream from a line from Portobello Point east to the opposite shore. All other areas are classified as "approved." The upstream limit of shellfish production in the estuary lies between Colonial Beach and Dahlgren, Virginia, on the western shore and just downstream from the Highway 301 Bridge on the eastern shore. The Potomac River produces about 13 per cent of the clams and 10 per cent of the oysters harvested in Maryland.

# SUMMARY OF WATER QUALITY IN THE POTOMAC RIVER BASIN IN MARYLAND

Numerous significant water quality problems exist in the Potomac River Basin in Maryland. In the 97-mile length of the North Branch, the wide-spread occurrence of mine drainage inhibits the development of normal biological life in many of the tributary streams as well as in the upper North Branch itself. Water containing mine drainage requires expensive treatment when used for municipal and industrial purposes. Iron and manganese are also present in concentrations which may require removal to satisfy some uses in this sub-basin. High bacterial counts and low dissolved oxygen concentrations are found in the lower third of the North Branch.

The 74-mile reach of the main stem Potomac River downstream from the confluence of the North and South Branches to Conococheague Creek gradually improves in quality over that found in the North Branch, because of dilution by better quality waters entering from West Virginia. However, due to discharges of untreated domestic wastes and run-off from agricultural areas, coliform bacteria are present throughout this reach in concentrations unsatisfactory for some uses when compared with criteria of the Interstate Commission on the Potomac River and Maryland Department of Water Resources.

Several tributaries which enter the Potomac River in the 95-mile reach from Conococheague Creek to the estuary have lowered water quality because of municipal or industrial waste discharges. Great quantities of suspended sediment are contributed by the Monocacy sub-basin, and high coliform bacteria levels occur in streams throughout the area at times of high spring stream flows. Tastes, odors, iron, and manganese are problems at times in surface water supplies in this area. The discharge of some untreated sewage and entry of inferior quality water from tributaries adversely affect dissolved oxygen levels in the upper third of this reach.

The quality of water in a 40-mile reach of the upper Potomac estuary is seriously diminished by pollution from wastewater discharges. Deleterious effects attributable to these wastes include very high bacterial levels, high concentrations of organic materials, a low and sometimes depleted dissolved oxygen content, and high nutrient concentrations which bring about massive algal blooms. The algal blooms discolor the water, reduce its clarity, and, in general, create a displeasing aesthetic appearance. The subsequent death, sedimentation, and decay of these organisms may contribute further to the unsatisfactory oxygen conditions in the upper estuary. Low dissolved oxygen levels may be a predisposing, if not primary, factor in some of the fish kills which are repeatedly observed in the Potomac. Suspended sediment entering at the head of the estuary from the Potomac River from surface runoff in the Washington Metropolitan Area and from sand and gravel operations also contributes to the excessive turbidity of the upper estuary.

In the lower estuary from U. S. Highway 301 Bridge to the mouth, water quality is generally satisfactory for most uses; however, occasional algal blooms and fish kills do occur. In addition, there are a few small isolated areas below waste outfalls where coliform bacteria concentrations are such as to prevent the commercial harvesting of shellfish. Depleted oxygen conditions in the deep waters near the mouth of the Potomac are observed annually during the warmest months of the year. This condition is common to all deep waters of the Chesapeake Bay.

The present (1965) water quality from Little Falls to Hallowing Point generally does not meet the objectives set for this reach of the estuary by the Interstate Commission on the Potomac River Basin. Results of studies have indicated that for the major portion of this reach, coliform and dissolved oxygen concentrations failed to meet the criteria established for these indicators more than 50 per cent of the time.

Diagrams illustrating the present water quality based on Interstate Commission on the Potomac River Basin criteria (Table I) and the Maryland Department of Water Resources (Table II) are presented in Figures 16 and 17, respectively.

# INDEX

[*]Aaron Run, 16
Abram Creek (W. Va.), 15
Academy of Natural Sciences of Philadelphia, 8, 45
Allegany Ballistics Laboratory of Hercules Powder Co. (Rocket Center, W. Va.), 20
Alpine Coal Co. (Henry, W. Va.), 14
Amcelle, Md., 21
Anacostia River, 52, 53
Antietam Creek (Md., Pa.), 33, 34, 36, 37, 38
Arlington, Va., County of, 58

Back Creek (Va., W. Va.), 30
Baltimore and Ohio Railroad (locomotive maintenance shop, Brunswick, Md.), 39
Barton, Md., 17
Barton's Dairy (Pinto, Md.), 20
Bayard, W. Va., 14, 15
Bel Air, Md., 20
Berkeley Springs, W. Va., 29
Berryville, Va., 38, 39
Bethesda, Md., 48
Blair Limestone Co. (Martinsburg, W. Va.), 36
Blue Plains Sewage Treatment Plant, Washington, D. C. (now called D. C. Water Pollution Control Plant), 48, 53, 56, 57, 58, 59, 60, 61
Boonsboro, Md., 37
Bowling Green, Md., 21, 22
Braddock Run, 23, 25
Breathedsville, Md., 37
Breton Bay, 65
Broad Run, 40
Brunswick, Md., 39
Buffalo Creek (W. Va.), 14, 15
Byron, W. D., and Sons Tannery (Williamsport, Md.), 34

Cabin John Creek, 48
Cacapon River (W. Va.), 27, 28, 29
Cambridge Rubber Company (Taneytown, Md.), 42
Carderock, Md., 48
Carroll Creek, 6, 43, 44, 49
Catoctin Creek (Md.), 40
Catoctin Creek (Va.), 40
Catoctin Furnace, Md., 43
Celanese Fibers Co. (Amcelle, Md.), 21
Chambersburg, Pa., 34
Chesapeake Bay, 8, 51, 52, 54, 58, 63, 65, 68
Chesapeake Bay Institute of The Johns Hopkins University, 8, 56
Chesapeake Bay-Susquehanna River Basins Project, 1, 24, 28, 29
Chesapeake Biological Laboratory University of Maryland (Solomons, Md.), 8
Chevy Chase, Md., 48
Cobb Island, Md., 65
Colesville, Md., 7, 53
Colonial Beach, Va., 65
Conococheague Creek (Md., Pa.), 27, 30, 33, 34, 35, 36, 67
Corning Packaging Co. (Frederick, Md.), 44
Cornwell, J. Lynn, Inc. (Purcellville, Va.), 40
Cresaptown, Md., 20, 21
Cullen, Victor, State Hospital (Sabillasville, Md.), 42

---

[*] Words underlined are names of streams or other bodies of water. State abbreviations are designated where streams are not entirely within the State of Maryland.

## INDEX (Continued)

Cumberland, Md., 7, 18, 21, 22, 23, 24
Cumberland Brewing Co. (Cumberland, Md.), 23
Cumberland Coca-Cola Bottling Co.(Cumberland, Md.), 23

Dahlgren, Va., 65
Dalecarlia Water Filtration Plant (of Washington Aqueduct Division), 48
Dashiell Dairy (Midland, Md.), 18
Dawsonville, Md., 46
Deakin Run (W. Va.), 14
Department of Sanitary Engineering and Water Resources of The Johns Hopkins University, 6
Detrick Creek, 43
Dickerson Generating Station (Dickerson, Md.), 44
Dickerson, Md., 8
Difficult Run (Va.), 46
District of Columbia (see Washington, Metropolitan Area of)
District of Columbia Blue Plains Sewage Treatment Plant (see Blue Plains)
District of Columbia Department of Public Health, 5
Dixon TB Hospital, Pa., 34
Double Pipe Creek, 42
DuPont de Nemours and Co. explosives plant (Falling Waters, W. Va.), 35

Elk Run (W. Va.), 14
Emmitsburg, Md., 42
E.U.B. Orphanage (Pa.), 37
Everedy Co. (Frederick, Md.), 43
Evitts Creek (Md., Pa.), 23, 24, 25

Fairchild Stratos Corp., The (Hagerstown, Md.), 37
Fairfax, Va., County of, 58
Fairview, Md., 34, 35
Falling Waters, W. Va., 35
Feeser, A. W. and Co. (Taneytown, Md.), 42
Fish and Wildlife Service (see U. S. Department of the Interior; Fish and Wildlife Service)
Fort Detrick (U. S. Army), Md., 43, 44
Fort Foote, Md., 54, 55, 61, 62
Fort Ritchie (National Guard), Md., 37
Fort Washington, Md., 54, 57, 60, 62, 63
Foxcroft School (Va.), 46
Fraley's Meats (Catoctin Furnace, Md.), 43
Frederick, Md., 7, 33, 43, 44, 49
Frederick, Md., County of, 7
Frostburg, Md., 17, 18, 23
Funkhouser Co. (Littlestown, Pa.), 42
Funkstown, Md., 37

Geological Survey (see U. S. Department of the Interior, Geological Survey)
Georges Creek, 17, 18, 19
Giesboro Point, 57, 60, 61, 62
Gilardi Run, 38
Goose Creek (Va.), 46
Goose Creek Country Club (Va.), 46
Great Falls, Md., 5, 33, 47, 48, 53, 54, 55, 57, 61
Greencastle, Pa., 34
Greencastle Packing Co. (Greencastle, Pa.), 34
Growdenvale, Md., 23

## INDEX (Continued)

Hadley Farms Dairy (Laytonsville, Md.), 46
Hagerstown, Md., 30, 31, 33, 37, 38
Hallowing Point, Md., 3, 52, 56, 61, 63, 68
Hancock, Md., 7, 24, 29, 35, 36
Harpers Ferry, W. Va., 38
Headsville, W. Va., 24
Heinz, H. J., Co. (Chambersburg, Pa.), 34
Henry, W. Va., 14
Herndon, Va., 46
Hopkins, The Johns, University (see Chesapeake Bay Institute, Department of Sanitary Engineering and Water Resources)
Hunting Creek, 42, 43
Hyattsville, Md., 53
Hyndman, Pa., 22

Indian Head, Md., 55, 57
Interstate Commission on the Potomac River Basin, 3, 5, 6, 15, 19, 22, 25, 30, 31, 39, 41, 44, 49, 52, 62, 67, 68
Interwoven Co. (Martinsburg, W. Va.), 36
Inwood, W. Va., 35

Jenkins Brothers (Frederick, Md.), 43
Jennings Run, 23, 25
Jug Bridge, Md., 44

Keedysville, Md., 38
Kelly-Springfield Tire Co. (Cumberland, Md.), 22, 23
Key Bridge, Washington, D. C., 62
Keyser, W. Va., 19, 20, 21
Kitzmiller, Md., 15

Late, Howard, and Company (Thurmont, Md.), 43
La Vale, Md., 23
Laytonsville, Md., 46
Leesburg, Va., 46
Linganore Creek, 44
Little Antietam Creek, 37, 38
Little Falls, 3, 49, 52, 62, 68
Little Falls Branch, 48
Little Tonoloway Creek (Md., Pa.), 29, 30
Lonoconing, Md., 17
Lotz Wholesale Meats Co. (Frostburg, Md.), 18
Lovers Point, Md., 65
Lovettsville, Va., 40
Lowengart and Co. (Mercersburg, Pa.), 34
Luke, Md., 14, 18, 20

Magin, George W., Co. (New Windsor, Md.), 42
Maloney Concrete Co. (Chevy Chase, Md.), 48
Marquette Cement Manufacturing Co.(Security Md.), 37
Marsh Creek (Pa.), 41
Marsh Run, 37
Marshall Hall, Md., 61
Martin-Marietta Corp., (Appalachian Stone Division) (Cumberland, Md.), 23
Martin-Marietta Corp., (Manley Sand Division), Hyndman, Pa., 23
Martinsburg, W. Va., 35, 36
Maryland Cooperative Milk Producers (Unionville, Md.), 44
Maryland Department of Chesapeake Bay Affairs, 7
Maryland Department of Water Resources, 6, 7, 14, 15, 19, 22, 25, 30, 31, 36, 41, 57, 67, 68
Maryland Point, Md., 56, 60

## INDEX (Continued)

Maryland State Department of Health (Baltimore, Md.), 7, 39, 42, 43, 44, 65
Maryland State Planning Department, 1
Maryland State Reformatory for Males (Breathedsville, Md.), 37
Maryland Water Pollution Control Commission, 3, 6, 44
Mason's Dairy (Cresaptown, Md.), 20
Memorial Bridge (Washington, D. C.), 5, 54, 55, 61
Mercersburg, Pa., 34
Middlesburg, Va., 46
Middletown, Md., 40
Mill Run, 20
Millville, W. Va., 38
Mississippi River, 48
Monocacy River, 3, 7, 33, 36, 41, 42, 43, 44, 49, 67
Mt. St. Joseph's Academy (Emmitsburg, Md.), 42
Mt. St. Mary's College (Emmitsburg, Md.), 42
Muddy Branch, 50
Municipal Electric Light Plant (Hagerstown, Md.), 37
Musselman Canning Co. (Inwood, W. Va.), 35
Myersville, Md., 40

National Fruit Co. (Martinsburg, W. Va.), 36
Neale Sound, Md., 65
New Creek (W. Va.), 19, 20, 22
New Windsor, Md., 42
North Branch Coal Co. (Bayard, W. Va.), 14
North Branch Potomac River, 5, 6, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 28, 67
North Fork of Linganore Creek, 44
Northeast Branch Anacostia River, 53
Northwest Branch Anacostia River, 7, 53

Ohio River Basin, 13
Oldtown, Md., 25
Opequon Creek (Va., W. Va.) 35, 36

Path Valley Esso (Chambersburg, Pa.), 34
Patterson Creek (W. Va.), 24
Paw Paw, W. Va., 28, 29
Pennsylvania Glass and Sand Co. (Berkeley Springs, W. Va.), 29
Philadelphia, Pa., 57
Piedmont, W. Va., 16, 18, 19, 20
Piney Creek, 42
Pinto, Md., 20
Pittsburgh Plate Glass Co. (Cumberland, Md.), 23, 24
Point-of-Rocks, Md., 7, 15, 33, 40, 45, 55, 61
Portobello Point, Md., 59
Possum Point, Va., 8, 55
Potomac Creamery Co. (Hagerstown, Md.), 37
Potomac Edison Co. (Cumberland, Md.), 22, 23
Potomac Edison Co., R. Paul Smith Station (Williamsport, Md.), 34
Potomac Electric Power Co. (PEPCO), 8, 44
Potomac Farms Quality Dairy Products (Cumberland, Md.), 23
Potomac Park, D. C., 61
Potomac River, 3, 8, 9, 24, 27, 28, 29, 30, 31, 33, 34, 35, 36, 38, 39, 40, 41, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 61, 62, 63, 64, 65, 67, 68

## INDEX (Continued)

Potomac River estuary, 8, 51, 52, 53, 57, 59, 61, 62, 63, 64, 65, 67, 68
Public Health Service (see U. S. Department of Health, Education, and Welfare, Public Health Service)
Public Health Service Drinking Water Standards, 55
Purcellville, Md., 40

Quantico Creek (Va.), 8
Queen City Brewing Co. (Cumberland, Md.), 23
Queen City Cooperative Dairy, Inc. (Cumberland, Md.), 23

Rawlings Heights, Md., 20
Reservoirs (see Savage Reservoir, Stony River Reservoirs)
Ridgeley, W. Va., 23
Riverdale, Md., 53
Rock Creek (Md.), 52, 53
Rock Creek (Pa.), 41

Sabillasville, Md., 42
St. Mary's River, 6, 65
Sandy Point, 50, 60
Sandy Spring Run, 18
Savage Reservoir, 16
Savage River, 16, 19
Scotland Orphanage (Pa.), 34
Security, Md., 37
Seneca Creek, 46
Shallmar, Md., 15
Sharpsburg, Md., 37, 38
Shenandoah River, 38, 39, 45
Shepherdstown, W. Va., 9, 36
Society Hill, Md., 65
Solomons, Md., 17
South Branch Potomac River, 27, 67
Standard Lime and Stone Co. (Martinsburg, W. Va.), 36
Stony River (W. Va.), 15
Stony River Reservoirs (W. Va.), 15, 16
Stream Classifications (see Classification of Streams) or (see Maryland Department of Water Resources or Interstate Commission on the Potomac River Basin)
Sugarland Creek (Va.), 46
Surveillance Station (see Williamsport, Great Falls, Memorial Bridge, Cumberland, Point-of-Rocks, Frederick, West Virginia Department of Natural Resources, Colesville, Shepherdstown, Oldtown, Md.)

Taneytown, Md., 42
Taylor, David, Model Basin (Carderock, Md.), 48
Thurmont, Md., 42, 43
Toms Creek (Md., Pa.), 42
Tonoloway Creek (Md., Pa.), 27, 30

Union Bridge, Md., 42
Unionville, Md., 44
U. S. Army Corps of Engineers 38
U. S. Department of Health, Education, and Welfare, Public Health Service, 5, 6, 8, 14, 31, 38, 47, 54, 56, 65
U. S. Department of the Interior, Fish and Wildlife Service, 9
U. S. Department of the Interior, Geological Survey, 1, 7, 29
U. S. Geological Survey (see U. S. Department of the Interior, Geological Survey)
U. S. Highway 301 Bridge, 8, 51, 52, 54, 55, 57, 63, 64, 65, 68
U. S. Naval Ordnance Laboratory (Whiteoak, Md.), 53
U. S. Navy Bureau of Ships, 48

## INDEX (Continued)

Upper Potomac River Commission Waste Treatment Facility (Westernport, Md.), 17, 18

Virginia Electric and Power Co. (Possum Point, Va., Steam Generating Plant), 8
Virginia Department of Conservation and Economic Development, Division of Water Resources, 8
Virginia State Department of Health, 8

Walkersville, Md., 43
Warm Springs Run (W. Va.), 29
Washington Aqueduct Division of U. S. Army Engineer District, 5, 47, 48
Washington (Metropolitan Area), 4, 6, 47, 48, 49, 51, 52, 53, 54, 56, 58, 60, 61, 68
Washington Petroleum Co. (Chevy Chase, Md.), 48
Washington Suburban Sanitary Commission, 47
Water Pollution Surveillance System, Public Health Service, 38, 47
Watts Branch, 46
Waynesboro, Pa., 37
Weinschel Engineering Co. (Gaithersburg, Md.), 46
West Branch of Marsh Run, 37
West Heating Plant (Washington, D. C.), 52
Western Maryland Railway Co. (Hagerstown, Md.), 37
Westernport, Md., 16, 17, 18, 19, 20
Westminster, Md., 42
West Virginia Department of Natural Resources, Division of Water Resources, 9, 39
West Virginia Pulp and Paper Co. (Luke, Md.), 5, 16, 17, 18, 19, 20
Williamsport, Md., 5, 31, 33, 34, 35, 36
Willow Farms Dairy (Westminster, Md.), 42
Wills Creek (Md., Pa.), 19, 22, 23, 25
Winchester, Va., 35
Wolfden Run, 15

Youghiogheny River - Ohio River Basin, 13

Zekiah Swamp, 6

14th Street Bridge, Washington, D. C., 51, 59, 61

# APPENDICES

# APPENDIX I. WATER QUALITY CRITERIA FOR THE POTOMAC RIVER IN THE WASHINGTON METROPOLITAN AREA

by
Interstate Commission on the Potomac River Basin
(Adopted January 22, 1958)

The ultimate goal of a comprehensive pollution abatement program is to provide that quality of water in the Potomac which will be compatible with the principal uses the people desire to make of them. Many uses are currently being made of the river even though the water quality is far from desirable for many such uses. Other uses are proposed for the future which can be realized only if pollution abatement is achieved. It is believed that the following water quality objectives and criteria for Five Sections of the Potomac River in the Washington Metropolitan Area are capable of achievement and desirable of attainment. Some aspects are admittedly long-range objectives. For example, the complete removal of raw sewage must await elimination of combined sewage and an application of practical methods of disposal of sewage and other wastes from boats. Nevertheless, the objectives are worthy goals and should be sought.

Because of the varying nature of the streams and the situations pertaining to them, no single set of water quality criteria can be made to apply to the entire Metropolitan region. The portion of the Potomac under consideration has been divided into Five Sections.

(1) Mouth of Monocacy to Great Falls

(2) Great Falls to Little Falls

(3) Little Falls to Key Bridge

(4) Key Bridge to Fort Washington

(5) Fort Washington to Hallowing Point

Key Bridge is the present division point between Sections (3) and (4), but this would be moved downstream to the vicinity of 14th Street Bridge in Washington at the proposed "Barrier Dam" if the provision for a water recreation basin is adopted as recommended in the Wolman Report entitled, "A Clean Potomac River in the Washington Metropolitan Area," November 1957.

## APPENDIX I. (Continued)

As a basic consideration applying to all Sections, the Commission advocates that all sewage or industrial wastes discharged or permitted to flow into tributaries of the Potomac should be treated to that extent, if any, which may be necessary to maintain such waters in a sanitary and satisfactory condition at least equal to the criteria recommended below for the waters of the Potomac immediately above the confluence of the tributary with the main stream.

The water quality objectives for the Sections indicated above are as follows:

### SECTION I

### POTOMAC RIVER: MONOCACY RIVER TO GREAT FALLS

Objective: The establishment of conditions suitable for domestic water supplies, fish propagation, and recreational uses, and elimination of excessive soil erosion.

Criteria: The water quality shall be held in the normal natural condition of the stream, with nearly all samples falling within the following limits:

1. Coliform Group: MPN not to exceed 2,000 per 100 ml.
2. pH: Range between 6.5 and 8.5.
3. D. O.: Monthly median not less than 6.5 ppm, with no D. O. below 4.0 ppm.
4. Turbidity: After opportunity for good mixing in the River, turbidity of the stream should not be appreciably changed.
5. Other Conditions: There shall be no floating solids, oil, settleable solids, or sludge deposits attributable to sewage, industrial wastes or other wastes. There shall be no toxic wastes, deleterious substances, colored or other wastes, or heated liquids, taste or odor producing substances, either alone or in combinations sufficient to be injurious to fish life or to make the waters unsafe or unsuitable as a source of municipal water supply or other desirable uses.

APPENDIX I. (Continued)

3. D. O.: Monthly average not less than 5.0 ppm, with no D. O. below 4.0 ppm.

4. Turbidity: After opportunity for good mixing in the River, turbidity of the stream should not be appreciably changed.

5. Other Conditions: There shall be no floating solids, oil, settleable solids, or sludge deposits attributable to sewage, industrial wastes or other wastes. There shall be no toxic wastes, deleterious substances, colored or other wastes or heated liquids, taste or odor producing substances, either alone or in combinations, in sufficient amounts to make the waters unsafe or unsuitable as a source of industrial process water supply, or for boating, shore recreation, passage of all species of fish or propagation of the hardier species of fish.

## SECTION V

## POTOMAC RIVER: FORT WASHINGTON TO HALLOWING POINT

Objective: To reduce the quality of combined sewage discharged and to control the quality of waste effluents by effective treatment of wastes and disinfection of effluents to make the water suitable for boating, fishing, swimming, and other recreational uses.

Criteria: The water quality shall be maintained so that the results of most of the samples fall within the following limits:

1. Coliform Group: MPN not to exceed 2,000 per 100 ml.

2. pH: Range between 6.5 and 8.5.

3. D. O.: Monthly average not less than 6.5 ppm, with no D. O. below 4.0 ppm.

4. Turbidity: After opportunity for good mixing in the River, turbidity of the stream should not be appreciably changed.

## APPENDIX I. (Continued)

5. Other Conditions: There shall be no floating solids, oil, settleable solids, or sludge deposits attributable to sewage, industrial wastes or other wastes. There shall be no toxic wastes, deleterious substances, colored or other wastes or heated liquids, taste or odor producing substances, either alone or in combinations, in sufficient amounts to be injurious to fish life or to make the waters unsafe or unsuitable for swimming, fishing, or other recreational uses.

## INTERPRETIVE NOTES:

In arriving at numerical values included in the foregoing objectives, it is the intent that A.P.H.A. Standard Methods be utilized. It is further intended with a series of samples, that arithmetical averages be used.

The reference "other wastes" under Condition No. 5 of the foregoing objectives shall be interpreted to include trash, garbage, dirt, soil, or any matter causing or aiding pollution.

With reference to disinfection of effluents for safeguarding of recreational areas, it is intended that the recreational season comprise the period of May 1 to September 30.

# APPENDIX II. SUMMARY OF ANALYSES OF WATER QUALITY DATA FOR THE NORTH BRANCH POTOMAC RIVER OBTAINED BY THE WEST VIRGINIA PULP AND PAPER COMPANY

## A. Above Luke, Maryland (River Mile 53.1)
Critical Concentrations (January 1962 - February 1965)

| Item | Units | Critical Month | High (H) or Low (L) | Mean | No. Observations for Critical Month |
|---|---|---|---|---|---|
| D. O. | mg/1 | July | L | 9.0 | 61 |
| Temperature | °C. | July | H | 19.6 | 61 |
| $B.O.D._5$ | mg/1 | July | H | 4.5 | 61 |
| pH | --- | August | L | 4.7* | 65 |
| Color | Platinum | July | H | 7 | 61 |
| Turbidity | Jackson Candle | March | H | 45.1 | 65 |
| Total Alkalinity | mg/1 | May | L | 4.0 | 65 |
| Hardness | mg/1 | July | H | 83.7 | 61 |
| Total Dissolved Solids | mg/1 | July | H | 217 | 61 |
| Suspended Solids | mg/1 | March | H | 47 | 65 |

* Geometric

## APPENDIX II. (Continued)

B. Below Luke, Maryland (River Mile 52.4)
Critical Concentrations (January 1962 - February 1965)

| Item | Units | Critical Month | High (H) or Low (L) | Mean | No. Observations for Critical Month |
|---|---|---|---|---|---|
| D. O. | mg/l | August | L | 7.1 | 65 |
| Temperature | °C. | July | H | 24.2 | 43** |
| $B.O.D._5$ | mg/l | September | H | 20.5 | 58 |
| pH | --- | October | H | 9.4* | 66 |
| Color | Platinum | October | H | 11 | 68 |
| Turbidity | Jackson Candle | October | H | 67.3 | 68 |
| Total Alkalinity | mg/l | April | L | 9.6 | 58 |
| Hardness | mg/l | July | H | 98.1 | 63 |
| Total Dissolved Solids | mg/l | July | H | 381 | 63 |
| Suspended Solids | mg/l | October | H | 169 | 68 |

* Geometric

** Two years only

APPENDIX II. (Continued)

C. At Keyser, West Virginia (River Mile 45.9)
Critical Concentrations (January 1962 - February 1965)

| Item | Units | Critical Month | High (H) or Low (L) | Mean | No. Observations for Critical Month |
|---|---|---|---|---|---|
| D. O. | mg/l | August | L | 6.8 | 65 |
| Temperature | $^{o}$C. | July | H | 24.0 | 41** |
| B.O.D.$_5$ | mg/l | December | H | 21.2 | 46 |
| pH | --- | September | H | 8.2* | 60 |
| Color | Platinum | August | H | 118 | 64 |
| Turbidity | Jackson Candle | October | H | 115.7 | 68 |
| Total Alaklinity | mg/l | April | L | 13.8 | 57 |
| Hardness | mg/l | October | H | 210 | 68 |
| Total Dissolved Solids | mg/l | October | H | 638 | 68 |
| Suspended Solids | mg/l | September | H | 154 | 56 |

* Geometric

** Two years only

## APPENDIX II. (Continued)

D. Upper Potomac River Commission Waste Treatment Facility,
Westernport, Maryland (River Mile 51.0)
Critical Concentrations (January 1962 - February 1965)

| Item | Units | Critical Month | High (H) or Low (L) | Mean | No. Observations for Critical Month |
|---|---|---|---|---|---|
| D. O. | mg/1 | April | L | 2.5 | 90 |
| $B.O.D._5$ | mg/1 | January | H | 82.0 | 124 |
| pH | --- | May | L | 6.8* | 93 |
| Color | Platinum | February | H | 829 | 84 |
| Turbidity | Jackson Candle | October | H | 420 | 93 |
| Total Dissolved Solids | mg/1 | June | H | 1,725 | 90 |
| Suspended Solids | mg/1 | August | H | 353 | 93 |

* Geometric

# APPENDIX III

## WATER QUALITY DATA FROM A SPECIAL STUDY OF THE UPPER POTOMAC RIVER BY THE PUBLIC HEALTH SERVICE IN 1965

## APPENDIX III. WATER QUALITY DATA FROM A SPECIAL STUDY OF THE UPPER POTOMAC RIVER THE PUBLIC HEALTH SERVICE IN 1965

| Location | River Miles to Mouth of Potomac | Date | Time | Stream Flow (cfs) | Water Temp. (°C.) | D.O. (mg/1) | B.O.D.5 (mg/1) | Coliform Bacteria (MPN/100 ml) | E. Coli Bacteria (MPN/100 ml) | Total Hardness (mg/1 as CaCO3) | Alkalinity (mg/1) | pH | Conductivity (μ mhos 25°C.) | Total Diss. Solids (mg/1) | Susp. Solids (mg/1) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cumberland, Md. | 304.7 | 7/14 | 0910 | 200 | 27.0 | 3.8 | 0.7 | 43,000 | 4,600 | 240 | 78 | 7.3 | 660 | 465 | 12 |
| | | 7/15 | 0310 | 166 | 28.5 | 3.2 | 1.1 | -- | -- | 220 | 74 | 7.8 | 610 | 437 | 10 |
| (Wiley Ford Bridge) | | 7/15 | 1430 | 166 | 29.5 | 3.9 | 2.5 | -- | -- | 220 | 70 | 8.4 | 610 | 431 | 22 |
| | | 7/16 | 1210 | 138 | 27.9 | 3.5 | 3.0 | 2,300 | 3 | 220 | 79 | 7.3 | 660 | 476 | 10 |
| | | Average | | 168 | 28.2 | 3.6 | 1.8 | 9,900 * | 120 * | 230 | 75 | 7.7 * | 635 | 452 | 13 |
| Below Cumberland | 296.3 | 7/14 | 1045 | -- | 26.0 | 3.0 | 0.7 | 2,300 | 2,300 | 250 | 87 | 7.2 | 810 | 547 | 3 |
| | | 7/15 | 0355 | -- | 27.0 | 3.8 | 0.9 | -- | -- | 280 | 82 | 7.2 | 750 | 552 | -- |
| (Pittsburg Plate-Glass Company Dam) | | 7/15 | 1500 | -- | 28.0 | 4.1 | 1.0 | -- | -- | 240 | 80 | 7.3 | 670 | 476 | 12 |
| | | 7/16 | 1115 | -- | 26.5 | 3.8 | 1.8 | 2,300 | 3 | 210 | 75 | 6.7 | 610 | 392 | 22 |
| | | Average | | -- | 26.8 | 3.6 | 1.1 | 2,300 * | 83 * | 250 | 81 | 7.1 * | 710 | 491 | 12 |
| Oldtown, Md. | 287.3 | 7/14 | 1120 | -- | 27.2 | 5.6 | 1.3 | 230 | 230 | 200 | 90 | 7.6 | 800 | 517 | -- |
| | | 7/15 | 0450 | -- | 27.0 | 5.1 | 2.3 | -- | -- | 220 | 93 | 7.3 | 740 | 491 | 16 |
| (Greenspring Bridge) | | 7/15 | 1540 | -- | 28.0 | 7.3 | 1.5 | -- | -- | 250 | 86 | 7.7 | 740 | 524 | 10 |
| | | 7/16 | 1035 | -- | 26.0 | 7.1 | 1.8 | 23,000 | 3 | 250 | 79 | 7.7 | 700 | 511 | -- |
| | | Average | | -- | 27.0 | 6.2 | 1.7 | 2,300 * | 26 * | 230 | 87 | 7.6 * | 745 | 510 | 13 |
| Paw Paw, W. Va. | 276.5 | 7/14 | 1215 | 748 | 27.9 | 7.5 | 1.1 | 43,000 | 43 | 150 | 91 | 8.0 | 460 | 300 | -- |
| | | 7/15 | 0530 | 574 | 26.5 | 6.5 | 1.5 | -- | -- | 150 | 97 | 7.9 | 495 | 320 | 2 |
| (Md. Rt. 51 Bridge) | | 7/15 | 1625 | 574 | 28.5 | 7.6 | 1.5 | -- | -- | 150 | 89 | 8.1 | 485 | 331 | -- |
| | | 7/16 | 0950 | 468 | 26.0 | 6.3 | 1.1 | 2,100 | 3 | 160 | 85 | 7.6 | 540 | 321 | 4 |
| | | Average | | 597 | 27.2 | 6.9 | 1.3 | 9,500 * | 4 * | 150 | 90 | 7.9 * | 495 | 318 | 3 |
| Hancock, Md. | 239.1 | 7/14 | 1405 | 1,200 | 29.2 | 8.5 | 1.0 | 2,300 | 43 | 150 | 91 | 8.5 | 445 | 297 | 0.4 |
| | | 7/15 | 0655 | 870 | 28.0 | 6.8 | 1.2 | -- | -- | 140 | 92 | 8.5 | 400 | 276 | -- |
| (U.S. Rt. 522 Bridge) | | 7/15 | 1725 | 870 | 29.2 | 8.8 | 0.9 | -- | -- | 140 | 86 | 8.7 | 430 | 292 | 0.0 |
| | | 7/16 | 0845 | 650 | 25.5 | 6.5 | 1.0 | 2,300 | 3 | 140 | 83 | 8.3 | 490 | 322 | -- |
| | | Average | | 907 | 27.9 | 7.6 | 1.0 | 2,300 * | 4 * | 140 | 88 | 8.5 * | 441 | 296 | 0.2 |

* Geometric mean

# APPENDIX IV. SUMMARY OF ANALYSES OF WATER QUALITY DATA FOR THE POTOMAC RIVER BASIN FROM THE PUBLIC HEALTH SERVICE WATER POLLUTION SURVEILLANCE SYSTEM

## A. POTOMAC RIVER AT WILLIAMSPORT, MARYLAND

### 1. Critical Concentrations

| Item | Units | Critical Month | High (H) or Low (L) | Minimum | Mean | Maximum | Coef. of Var.%** | No. Observations for Critical Month |
|---|---|---|---|---|---|---|---|---|
| D.O. | mg/1 | Aug. | L | 6.0 | 7.5 | 8.7 | 13 | 6 |
| D.O. | % sat. | Oct. | L | 69 | 81 | 81 | 9 | 6 |
| Temp. | $^{o}$C. | July | H | 22.8 | 25.1 | 27.8 | 6 | 16 |
| B.O.D.$_5$ | mg/1 | Nov. | H | 0.3 | 1.3 | 2.6 | 77 | 4 |
| C.O.D. | mg/1 | Annual | H | 9 | 12 | 21 | 36 | 8 |
| pH | --- | Aug. | H | 7.6 | 7.9* | 8.6 | 1* | 20 |
| Coliform Bacteria | MF/100 ml | May | H | 10 | 590* | 6,200 | 27* | 16 |
| Color | Platinum | Oct. | H | 5 | 13 | 30 | 62 | 14 |
| Turbidity | Jackson Candle | Mar. | H | 6 | 96 | 1,000 | 245 | 17 |
| Total Beta Radio-activity | pc/1 | Feb. | H | 6 | 43 | 85 | 82 | 7 |

* Geometric

** Coefficient of Variation equals standard deviation divided by the mean.

## APPENDIX IV. (Continued)

### A. POTOMAC RIVER AT WILLIAMSPORT, MARYLAND

### 2. Critical Mass Flow Rates

| Item | Units | Critical Month | High (H) or Low (L) | Minimum | Mean | Maximum | Coef. of Var.%** | No. Observations for Critical Month |
|---|---|---|---|---|---|---|---|---|
| D.O. | lbs/day (1,000's) | Sept. | L | 14 | 24 | 34 | 41 | 3 |
| $B.O.D._5$ | lbs/day (1,000's) | Apr. | H | 16 | 41 | 61 | 47 | 4 |
| C.O.D. | lbs/day (1,000's) | Annual | H | 64 | 570 | 2,200 | 139 | 8 |
| Coliform Bacteria | MF/day ($10^{12}$'s) | Mar. | H | 520 | 9,900* | 210,000 | 6* | 14 |
| Total Beta Radio-activity | uc/day (1,000's) | Apr. | H | 176 | 727 | 1,590 | 82 | 7 |

* Geometric

** Coefficient of Variation equals standard deviation divided by the mean.

## APPENDIX IV. (Continued)

### B. SHENANDOAH RIVER AT BERRYVILLE, VIRGINIA

#### 1. Critical Concentrations

| Item | Units | Critical Month | High (H) or Low (L) | Minimum | Mean | Maximum | Coef. of Var.%** | No. Observations for Critical Month |
|---|---|---|---|---|---|---|---|---|
| D.O. | mg/1 | July | L | 6.0 | 7.2 | 8.1 | 12 | 4 |
| D.O. | % sat. | Oct. | L | 62 | 80 | 87 | 9 | 10 |
| Temp. | $^{o}$C. | July | H | 22.5 | 25.4 | 28 | 8 | 9 |
| B.O.D.$_5$ | mg/1 | Aug. | H | 3.7 | 5.1 | 6.7 | 20 | 6 |
| C.O.D. | mg/1 | Annual | H | 7 | 25 | 49 | 61 | 8 |
| pH | --- | Dec. | H | 7.8 | 8.4* | 9.7 | 3* | 17 |
| Coliform Bacteria | MF/100 ml | Oct. | H | 5.0 | 300* | 23,000 | 61* | 8 |
| Color | Platinum | Mar. | H | 0 | 8 | 20 | 85 | 11 |
| Turbidity | Jackson Candle | Mar. | H | 25 | 120 | 550 | 134 | 11 |
| Total Beta Radio-activity | pc/1 | Mar. | H | 24 | 70 | 126 | 66 | 6 |

* Geometric

** Coefficient of Variation equals standard deviation divided by the mean.

## APPENDIX IV. (Continued)

### B. SHENANDOAH RIVER AT BERRYVILLE, VIRGINIA

#### 1. Critical Concentrations (Continued)

| Item | Units | Critical Month | High (H) or Low (L) | Minimum | Mean | Maximum | Coef. of Var.%** | No. Observations for Critical Month |
|---|---|---|---|---|---|---|---|---|
| Chloride | mg/1 | Sept. | H | 9 | 21 | 35 | 43 | 10 |
| Total Alkalinity | mg/1 | Mar. | L | 64 | 77 | 88 | 12 | 11 |
| Hardness | mg/1 | Oct. | H | 112 | 181 | 240 | 17 | 17 |
| Total Dissolved Solids | mg/1 | Oct. | H | 144 | 305 | 440 | 31 | 13 |
| Sulfate | mg/1 | Sept. | H | 64 | 133 | 240 | 47 | 10 |
| Phosphate | mg/1 | Jan. | H | 0 | 0.1 | 0.8 | 265 | 7 |

---

** Coefficient of Variation equals standard deviation divided by the mean.

# SOURCES OF WATER QUALITY DATA*

Each year the Interstate Commission on the Potomac River Basin publishes a report entitled, Potomac River Water Quality Network--Compilation of Data. These annual reports have been published beginning with the water year 1960; a biennial report was published for water years 1958 and 1959; and one report summarized water years 1950 - 1957. Included for each network station are monthly averages of up to four samples for temperature, turbidity, alkalinity, pH, dissolved oxygen, biochemical oxygen demand, total and coliform bacteria, suspended and total solids, together with the corresponding stream discharges. Samples are collected and analyzed by several industries and governmental agencies located throughout the Basin. The total number of stations reported in 1964 was 77, of which 56 were in Maryland waters. The Commission, in cooperation with the Washington Aqueduct Division, U. S. Army Engineer District, Baltimore, and the District of Columbia Department of Public Health, is conducting a special bacteriological study of the major watersheds of the Basin to define possible contributions to high bacterial counts which occur during high flows at Great Falls; however, since insufficient data have been collected to date, an evaluation cannot be made at this time.

In addition to contributing data to the Commission's network, several industries and governmental jurisdictions obtain more detailed water quality data, especially at water supply intakes. Of special significance are daily samples at three locations on the North Branch Potomac River by the West Virginia Pulp and Paper Company at Luke, Maryland, and on the Potomac River at Great Falls, Maryland, by the Washington Aqueduct Division of the U. S. Army Engineer District, Baltimore. Other jurisdictions not participating in the network also routinely maintain water quality records for water supplies.

The U. S. Department of Health, Education, and Welfare, Public Health Service, maintains four stations of the nation-wide Water Pollution Surveillance System in the Potomac River Basin, three of which are located in Maryland. The stations at Williamsport and Great Falls, Maryland, were activated in October 1957, and the station at Memorial Bridge, Washington, D. C., was activated in July 1963. The data on chemical, physical, and bacteriological analyses and radiological determinations are generally determined weekly; plankton counts are made twice a month; organic chemicals by carbon filter technique are determined monthly; three-month composite samples are analyzed twice annually for metallic elements and Strontium 90 activity; and occasional determinations of alkyl benzene sulfonate are made. These data are published in annual compilations. The Public Health Service performed water quality field surveys during the period 1956 - 1960 in the Potomac River Basin with emphasis given to problem areas. The resulting data are published in Potomac River Basin Report, Volume V, Appendix E, U. S. Army Engineer District, Baltimore, Maryland, February 1963. Data on the Potomac River estuary from those surveys are presented in Technical Appendix to Part VII of the Report on the Potomac River Basin Studies, Report on Needs for Water Supply and Flow Regulation for Quality Control in the Washington Standard Metropolitan Area, August 1962, by the Public Health Service. The Public Health Service performed special studies on the bottom and plankton conditions of the Potomac River in the Washington Metropolitan Area for the Interstate Commission on the Potomac River Basin in 1952, and the results are presented in A Report on Water Pollution in the Washington Metropolitan Area, Section III - Appendices, "Appendix A - Bottom and Plankton Conditions in the Potomac River in the Washington Metropolitan Area," Interstate Commission on the Potomac River Basin, Washington, D. C., February 1954.

---

* While much related historical information is available, only data pertinent to present water quality are included.

The Maryland Department of Water Resources initiated a Western Maryland Mine Drainage Survey in 1962 to define reaches of streams receiving acid mine drainage and to assist in locating sources of the mine drainage. Interim Report #1 on the Western Maryland pH Survey, published in June 1963, presents pH data for 1962 and 1963 from the North Branch drainage area. Based upon those data, more detailed studies of acid mine drainage have continued during 1964 and 1965, but these findings have not been published to date. That Department (under the former name of Maryland Water Pollution Control Commission) has also prepared the following: Final Data Report for Zekiah Swamp 3/9/61 - 2/28/62, August 1962; Carroll Creek Survey - 1961; and St. Mary's River Water Quality Survey - 1962; presenting data from water quality surveys on these three streams of the Potomac River Basin. Under contract to the Maryland Department of Water Resources, the Department of Sanitary Engineering and Water Resources of The Johns Hopkins University made a study in 1962-63 resulting in a report entitled Anionic Detergents in Maryland Waters and Wastes, with Dr. Charles E. Renn as Responsible Investigator. Subsequent to that study, the Nation's detergent industry has converted to the production of bio-degradable or "soft" detergents, which are more easily broken down in waste treatment plants and in streams. As a result, the 1962-63 data would be of limited value in describing present water quality.

The Maryland State Department of Health conducted a water quality survey of the Monocacy River in September 1964. The data are presented in Report on Basic Sewerage System, Frederick County Western Suburban Area, to the Frederick County Metropolitan District and Sanitary Commission, Benjamin E. Beavin Company, Baltimore, Maryland, 1964. The State Department of Health has made studies of shellfish harvesting areas in the Potomac River estuary for many years. An intensive study of the bacteriological quality of these areas was made during the fall of 1964 in cooperation with the Maryland Department of Water Resources and the Maryland Department of Chesapeake Bay Affairs, but these data have not been published. Occasional analyses of community water supplies drawn from surface waters of the Potomac River Basin are also made by the State Department of Health.

The U. S. Department of the Interior, Geological Survey, is maintaining, as of January 1965, four stations in the Potomac River Basin to determine daily suspended-sediment discharge. Two of these stations, near Cumberland and at Point-of-Rocks, are on the Potomac River, and the other two on tributaries, i.e., the Monocacy River near Frederick and the Northwest Branch Anacostia River near Colesville. At three of these stations, Cumberland, Point-of-Rocks, and Frederick, samples are obtained monthly for chemical analysis of the common constituents. The data resulting from these analyses and from studies begun in 1959 of the suspended sediment in the Potomac River Basin are published in annual reports entitled Quality of Surface Waters of the United States. Daily temperature records are also published in these reports and four thermographs are now (1965) installed at selected gaging stations in the Potomac River Basin. The longest period of record of these thermographs, that of the Potomac River at Hancock, has been continuously operated since July 1952. Miscellaneous chemical analyses at other stations in the Basin are also included in the annual surface water quality reports. Sediment data through April 1961 are summarized and discussed in Potomac River Basin Report, Volume VII, Appendix H, Sediment Studies, U. S. Army Engineer District, Baltimore, Maryland, 1962. The Geological Survey summarizes and discusses suspended sediment data collected through April 1962 in Preliminary Study of Sediment Sources and Transport in the Potomac River Basin, Technical Bulletin 1963-11, Interstate Commission on the Potomac River Basin, Washington, D. C., June 1963. The Geological Survey has also published (1961) a report entitled, Water Quality and Hydrology in the Fort Belvoir Area, Virginia, 1954 - 1955, which considers the quality of the Potomac River estuary in Maryland. The Potomac River at Point-of-Rocks is also one of the sampling stations in the Geological Survey tritium network, and composite samples are analyzed monthly for this radioisotope.

The Chesapeake Bay Institute of The Johns Hopkins University has published Atlas of Salinity and Temperature Distributions in Chesapeake Bay, 1952 - 1961, and Seasonal Averages, 1949 - 1961 by E. D. Stroup and R. J. Lynn, February 1963, and Atlas of the Distribution of Dissolved Oxygen and pH in Chesapeake Bay 1949 - 1961 by R. I. Hires, E. D. Stroup, and R. C. Seitz, December 1963, under contract to the Public Health Service. Those atlases display the results obtained during cruises of the Institute and include the Potomac River estuary from Chesapeake Bay to U. S. Highway 301.

The Virginia Department of Conservation and Economic Development, Division of Water Resources, has periodically published reports entitled, Chemical Character of Surface Waters of Virginia. Chemical analyses of Potomac River tributary streams are generally available since 1948, with some miscellaneous analyses available in earlier years.

The Virginia State Department of Health determines the bacteriological quality of the bays and coves of the Potomac River estuary in Virginia which are active or potential shellfish harvesting areas.

The Potomac Electric Power Company has studied the effects of raised temperature on the Potomac River in the vicinity of its thermo-electric power plant at Dickerson, Maryland. Temperature data are summarized graphically in several reports of the Company, and studies of biological flora before and after the plant began operation were performed for the Company by the Academy of Natural Sciences of Philadelphia and published in three reports on the surveys of 1956, 1960, and 1961.

The Possum Point steam generating plant of the Virginia Electric and Power Company, located on the Potomac River estuary at the mouth of Quantico Creek in Virginia, has sampled the Potomac estuary waters daily for many years. Analyses are performed for temperature, ammonia, hardness, chlorides, and other quality indicators.

The Chesapeake Biological Laboratory of the Natural Resources Institute, University of Maryland, Solomons, Maryland, in a study under R. D. Van Deusen, classified Maryland freshwater streams as to type of fish population which could be supported. The classifications are shown on maps of the State in

Until recently, Keyser, West Virginia, discharged an estimated 360,000 gpd of untreated sewage from 4,500 persons. Since August 1965, a primary treatment plant which discharges to the North Branch at River Mile 45.4 has been in operation.

A quality station on the North Branch at River Mile 45.9, just downstream from an old outfall, is sampled daily by the West Virginia Pulp and Paper Company. Prior to completion of the treatment plant, this outfall discharged a portion of Keyser's sewage. Since the sewage discharged appeared to flow along the bank of the River opposite the sampling station, analyses of the results, summarized in Appendix II, were interpreted on the assumption that none of the sewage flow from Keyser was mixed with the River at that sampling point. Even though the acid of the North Branch is neutralized by the alkaline wastes of West Virginia Pulp and Paper Company much of the time, high iron and manganese concentrations persist beyond this point.

Savage River meets the requirements for INCOPOT Class A and MDWR Class AA. Georges Creek does not meet the minimum standards for INCOPOT Class D because of pH values below 6.0 and B.O.D. values above 5.0 mg/1, and falls into MDWR Class C because of B.O.D. values over 7.0 mg/1. The main stem of the North Branch in this sub-reach does not meet minimum standards for INCOPOT Class D because of pH values in excess of 8.5, B.O.D. values over 5.0 mg/1, high color, and offensive odors, and falls into MDWR Class C because of B.O.D. values over 7.0 mg/1, pH values over 10.5, and the presence of taste and odor producing substances.

### New Creek to Wills Creek (24.0 miles)

The North Branch Potomac River flowing into this sub-reach (beginning at River Mile 45.7) contains high concentrations of B.O.D. (a range of monthly means of 12.7 mg/1 to 23.7 mg/1), and yet, the dissolved oxygen content remains high (a range of monthly means from 6.1 mg/1 to 13.1 mg/1) and remains essentially constant for the next five miles to River Mile 40 (where the monthly mean range is 5.7 mg/1 to 13.3 mg/1). Downstream from that point, the dissolved oxygen concentration begins to drop (to about 5.0 mg/1 at River Mile 28.9 during hot weather). There are three possible explanations for the somewhat unusual dissolved oxygen profile. First, the fall in the River between the Piedmont-Westernport area (River Mile 51), where organic wastes enter the River, and River Mile 40 is about 16 feet per mile, indicating the likelihood of a very high degree of aeration; whereas, the fall for the 10 miles below River Mile 40 is only about 8 feet per mile. Second, the stream waters approaching the region in which organic wastes are discharged (Luke-Piedmont-Westernport area) are highly acid and are almost biologically sterile. Even though the acid is neutralized at Luke much of the time by wastes from the West Virginia Pulp and Paper Company, a certain amount of time is required before the River can establish a biological flora which can decompose the organic wastes and thus reduce dissolved oxygen concentrations. Also, until recently, the untreated sewage from Keyser, West Virginia, entered the River at River Mile 46.2 and from New Creek (River Mile 45.7) and contained large numbers of microorganisms which acted to "seed" the River. Third, wastes from Keyser, Bel Air (River Mile 32.7), Barton's Dairy (River Mile 32.6), the Allegany Ballistics Laboratory (River Mile 32.5), Mason's Dairy (River Mile 29.7), and Cresaptown (River Mile 29.5) add to the biological population and the organic loading in the 10-mile reach of the River in which the dissolved oxygen concentration drops.

The community of Rawlings Heights obtains its water supply from an unnamed tributary of Mill Run, which enters the North Branch at River Mile 35.0.

The community of Bel Air, with an estimated sewered population of 400, discharges its waste effluent after treatment by lagoon to the North Branch at River Mile 32.7. The loading from the town is estimated to be about 10 pounds of B.O.D. per day in a flow of 30,000 gpd.

Barton's Dairy at Pinto, Maryland, discharges an unknown quantity of milk processing wastes at River Mile 32.6.

The average annual sediment discharge measured at Pinto, Maryland (River Mile 32.6) is 130 tons per square mile, or 78,000 tons per year.

The Allegany Ballistics Laboratory of Hercules Powder Company at Rocket Center, West Virginia, discharges approximately 100,000 gpd of sanitary wastes from about 2,000 persons to the North Branch at River Mile 32.5 after secondary treatment. No significant quantities of industrial wastes are discharged to the River from this plant. The total waste loading to the River is estimated to be 50 pounds of B.O.D. per day.

Mason's Dairy at Cresaptown, Maryland, discharges about 35,000 gpd of milk processing wastes at River Mile 29.7. The loading is about 20 pounds of B.O.D. per day.

Williamsport, Maryland, discharges 30,000 gpd of sewage effluent from 1,900 persons, after primary treatment, to the Potomac River at River Mile 210.3. The organic waste loading is about 210 pounds of B.O.D. per day.

The water quality of the Potomac River is affected by the Conococheague Creek waters and the sewage effluent discharge from Williamsport, but not to a point causing nuisance conditions because of the large amounts of dilution afforded by the Potomac. The stream flow of Conococheague Creek at Fairview, Maryland, 18.0 miles upstream of its mouth, averaged 561 cfs over 35 years, as compared to 3,999 cfs over 31 years for the Potomac River at Hancock, Maryland. Generally, the maximum B.O.D. in the Potomac River increases from 1.0 mg/l upstream of Conococheague Creek to about 1.5 mg/l downstream of the Creek and Williamsport; the annual average alkalinity increases from about 50 mg/l upstream to about 100 mg/l downstream; and the maximum monthly coliform bacteria counts increase from about 600 to about 2,000/100 ml. Limited data are available on dissolved oxygen concentration; however, it appears that the dissolved oxygen concentration decreases slightly from 85 per cent saturation upstream to about 80 per cent saturation downstream much of the time during warm weather. Dissolved oxygen concentrations are near saturation during some days downstream to Conococheague Creek and Williamsport. This may be the result of photosynthesis by growths of plant life stimulated by nutrients in the tannery wastes (typically high in nitrogen content), and in the Williamsport sewage effluent. Night-time sampling would be necessary to determine daily minimum concentrations of dissolved oxygen. The Potomac River below Conococheague Creek and Williamsport has a hardness of approximately 125 mg/l, and contains some taste and odor producing substances.

The E. I. DuPont de Nemours and Company explosives plant at Falling Waters, West Virginia, discharges 10,000 gpd of sanitary wastes from 420 persons, after intermediate (approximately 50 per cent B.O.D. removal) treatment, and 500,000 gpd of industrial wastes to the Potomac River at River Mile 205.4. The industrial waste loading is unknown. Nitrogenous substances are typical of this type of industrial waste.

Opequon Creek enters the Potomac River from West Virginia at River Mile 202.0. Opequon Creek and its tributaries receive 2.5 mgd of sewage effluent from Winchester, Virginia, after secondary treatment; 300,000 gpd of canning wastes from the Musselman Canning Company in Inwood, West Virginia, after intermediate (approximately 60 per cent B.O.D. reduction) treatment; 2.5 mgd of sewage effluent from 12,000 persons at Martinsburg, West Virginia, after secondary treatment; and a total of about 750,000 gpd of industrial wastes from the National Fruit Company, Interwoven Company, Standard Lime and Stone Company, and Blair Limestone Company at Martinsburg, none of whose waste loadings are known. Below Martinsburg, Opequon Creek has a B.O.D. of approximately 3.0 mg/l, with values at times greater than 5.0 mg/l. The hardness is about 250 mg/l, alkalinity about 225 mg/l, and coliform bacteria frequently exceed 10,000/100 ml. Dissolved oxygen concentrations fall to 3.5 mg/l at Martinsburg during warmest periods with corresponding low stream discharges, but lower D.O. values may occur between this point and the confluence with the Potomac, 8.3 miles downstream. Opequon Creek, near Martinsburg, has a moderate average annual sediment discharge of 97 tons per square mile, or 26,400 tons per year. The stream flow added to the Potomac River by the Opequon is relatively small (204 cfs average over 16 years at Martinsburg, as compared to a 3,999 cfs average over 31 years on the Potomac River at Hancock), so that the water quality of the Potomac River is not seriously affected by the lower quality water from Opequon Creek.

Shepherdstown, West Virginia, obtains its water supply from the Potomac River at River Mile 183.6 and provides spray aeration to remove tastes and odors during the treatment process. The Potomac River at Shepherdstown has a hardness of about 125 mg/l and an alkalinity of about 100 mg/l. Coliform bacteria concentrations are generally less than 2,000/100 ml. Dissolved oxygen concentrations are normally greater than 6.5 mg/l and fall below 5.0 mg/l only rarely during the warmest weather. B.O.D. levels average about 1.5 to 2.0 mg/l at this point.

Shepherdstown discharges 150,000 gpd of untreated sewage from 2,000 persons at about River Mile 183.0. The loading is estimated to be 340 pounds of B.O.D. per day.

Conococheague Creek may be classified as INCOPOT Class D and MDWR Class C because of taste and odor producing substances. The taste and odor problem is moderate above Williamsport but great below Williamsport. The Potomac River in this sub-reach may be classified as INCOPOT Class D because of dissolved oxygen concentrations below 5.0 mg/l and the presence of taste and odor producing substances, and MDWR Class B because of dissolved oxygen concentrations between 3.0 and 5.0 mg/l, with an average of about 4.0 mg/l.

## Antietam Creek to Monocacy River (26.7 miles)

Antietam Creek, as it enters Maryland from Pennsylvania at River Mile 37.0, contains 1.2 mgd of secondary sewage effluent

The head of tide on the Potomac River begins just below the lower end of Little Falls (River Mile 116.1). The average Potomac River discharge to the estuary is 11,040 cfs (33 years of record, measured two miles upstream of the District of Columbia boundary).

The Monocacy River, in the approximately 15-mile reach upstream of Frederick, may be classified as INCOPOT Class C because of mean coliform bacteria counts between 500 and 5,000/100 ml, and MDWR Class A because of average B.O.D. concentrations between 1.0 and 2.5 mg/l. In a reach just below the Pennsylvania State line, about five miles in length, the Monocacy River does not meet the minimum criteria for INCOPOT Class D and must be classified as MDWR Class C because of dissolved oxygen concentrations less than 2.0 mg/l. In between these two reaches, the remaining 12 miles probably falls within INCOPOT Class D and MDWR Class B, since monthly coliform bacteria concentrations are estimated to range from 2,000 to 10,000/100 ml. The Monocacy River below Frederick must be classified as not meeting INCOPOT Class D minimum criteria, and as MDWR Class C, because mean monthly coliform bacteria concentrations exceed 10,000/100 ml, and dissolved oxygen concentrations fall to 1.0 mg/l. Carroll Creek of the Monocacy River must also be classified as not meeting INCOPOT Class D, and as MDWR Class C because of large quantities of floating solids and debris. Even though coliform bacteria counts were not obtained in the survey of Carroll Creek in 1961, high counts would be suspected in this small stream which traverses densely populated areas. Low dissolved oxygen concentrations could also be suspected, since B.O.D. concentrations over 4.0 mg/l were found.

The Interstate Commission on the Potomac River has established specific objectives and criteria for the main stem Potomac River from the Monocacy River to Little Falls which are presented in Appendix I. The classification system used upstream is, therefore, not utilized for the main stem Potomac River in this subreach and below. The Potomac River is well within the criteria set by the Interstate Commission for this sub-reach during most of the year. However, during the high stream flow periods of March through May, the monthly median coliform bacteria concentrations are greater than 2,000/100 ml, at times taste and odor producing substances are present, and occasionally individual pH values exceed 8.5. On very rare occasions, the dissolved oxygen concentration has been below 4.0 mg/l. The Potomac River in this sub-reach would be MDWR Class B, since monthly mean coliform bacteria concentrations lie between 2,000 and 10,000/100 ml, monthly mean dissolved oxygen concentrations lie between 4.0 and 6.0 mg/l with no value falling below 3.0 mg/l, and monthly average

B.O.D. concentrations fall between 2.5 and 6.0 mg/l. Seneca Creek may be classified as INCOPOT Class D and MDWR Class B, because of monthly geometric mean coliform bacteria concentrations between 2,000 and 10,000/100 ml and monthly average B.O.D. concentrations between 2.5 and 6.0 mg/l. Muddy Branch, which enters the Potomac River at River Mile 131.4, may be classified as INCOPOT Class D and MDWR Class B, because of monthly mean coliform bacteria concentrations between 2,000 and 10,000/100 ml.

the summer months. The turbidity criterion is not met because of storm runoff, and the nutrients in waste effluents could be interpreted as deleterious substances which make the waters unsuitable, through the stimulation of algal growths, for boating and shore recreation. The fish kills observed in this and lower reaches of the estuary are ample evidence that the waters are unsafe for the passage of all species of fish. It is not possible to state conclusively at this time, however, that this condition is brought about by man-made pollution.

In the lowest reach for which objectives and criteria have been established; i.e., Fort Washington (River Mile 97.8) to Hallowing Point (River Mile 89.5), the water uses to be protected are boating, fishing, swimming, and other recreational uses. The coliform criterion of 2,000/100 ml is exceeded in most of the samples collected in this reach during most of the year. The minimum monthly average dissolved oxygen of 5.0 mg/l, with no dissolved oxygen below 4.0 mg/l, is likewise not achieved at all times. The comments on the upstream reaches pertaining to effects of algae and low water transparency on suitability of the water for recreational purposes and to fish kills apply in this reach as well.

## U. S. Highway 301 Bridge to Mouth of Potomac (48.8 miles)

In the lower Potomac estuary from the U. S. Highway 301 (Morgantown) Bridge to the River mouth, there is always present a detectable amount of sea salts which diffuse up the estuary from Chesapeake Bay. These concentrations are highest during the later summer and fall months due to the low fresh water inflows to the Potomac estuary and to the entire Bay system which are experienced at this time. During the fall months, salinities[*] average approximately 9.0 and 11 parts per thousand at the surface and at a 30-foot depth, respectively, near the Highway 301 Bridge. This vertical stratification in the fall is not as pronounced with respect to temperature, which averages near 52°F., through the water column. Surface dissolved oxygen values are generally near 7.0 mg/l, although values up to 11 mg/l may be found in late fall when temperatures have dropped. Little information is available on bottom oxygen conditions in the Highway 301 Bridge area.

---

[*] 1 ppt salinity is approximately equal to 550 mg/l chlorides.

At the mouth of the Potomac during late summer and fall, the salinities are the highest experienced in the Potomac estuary, usually being about 17 ppt at the surface and 18 ppt at the 30-foot depth. Surface water temperatures in the fall are warmer at the mouth than upstream, being near 57°F. at the surface and about two degrees less at a 30-foot depth. Surface dissolved oxygen values are similar to those experienced upstream, 6.0 to 7.0 mg/l during the warmer fall months and rising to 10 and 11 mg/l during late fall. At a 40-foot depth at the mouth, the dissolved oxygen concentrations are generally 1.0 to 3.0 mg/l less than surface values; pH values of 8.0 and 8.4 have been reported at 40 feet and the surface, respectively.

During the winter months, the salinity at Highway 301 Bridge drops to about 5.0 ppt under the influence of increased fresh water inflows. Temperatures are usually near 36°F., and saturated dissolved oxygen concentrations are normally present. A similar effect is felt at the mouth, where salinities are about 13 and 15 ppt at the surface and at a 40-foot depth, respectively. Water temperatures are usually two to four degrees warmer at the mouth than at Highway 301 Bridge. Saturated dissolved oxygen conditions may be found both at the surface and at the deeper waters near the mouth.

During the spring months, salinities are at their lowest values, coinciding with highest fresh water inflows. At the Highway 301 Bridge, salinity is usually near 3.0 ppt at the surface and 4.0 ppt at a 30-foot depth. Surface temperatures average 57°F. at the surface, being two to four degrees cooler in the deeper waters. Dissolved oxygen concentrations are near saturation at the surface and may be significantly less near the bottom at this time, although little data are currently available; pH values near 8.0 are usually found. At the mouth, surface salinity may drop to 10 ppt and is some 2.0 to 3.0 ppt higher in the bottom layers. Water temperatures are similar to those found near the Highway 301 Bridge, and pH values usually lie between 8.0 and 9.0.

During the summer months, salinities in the lower estuary begin their annual upward rise, as fresh water inflows drop off. Vertical stratification is also most pronounced at this time of year, as reflected by salinity, temperature, and dissolved oxygen concentrations. Surface and 30-foot salinities are usually 7.0 and 10 ppt at Highway 301 Bridge and 13 and 16 ppt, respectively, at the mouth of the estuary. Average surface water temperatures are at or above 81°F. throughout the entire lower estuary and are two to four degrees cooler at a depth of 30 feet. Very striking dissolved oxygen conditions are found in the lower

## APPENDIX I. (Continued)

## SECTION II

### POTOMAC RIVER: GREAT FALLS TO LITTLE FALLS

Objective: The elimination of sewage and waste effluent and excessive soil erosion so that the water will be suitable for domestic water supplies and fish life.

Criteria: The water quality shall be held in the normal natural condition of the stream, with nearly all samples falling within the following limits:

1. Coliform Group: MPN not to exceed 2,000 per 100 ml.
2. pH: Range between 6.5 and 8.5.
3. D. O.: Monthly median not less than 6.5 ppm, with no D. O. below 4.0 ppm.
4. Turbidity: After opportunity for good mixing in the River, turbidity of the stream should not be appreciably changed.
5. Other Conditions: There shall be no floating solids, oil, settleable solids, or sludge deposits attributable to sewage, industrial wastes or other wastes. There shall be no toxic wastes, deleterious substances, colored or other wastes, or heated liquids, taste or odor producing substances, either alone or in combinations in sufficient amounts to be injurious to fish life or to make the waters unsafe or unsuitable as a source of municipal water supply or other desirable uses.

## SECTION III

### POTOMAC RIVER: LITTLE FALLS TO KEY BRIDGE

Objective: The elimination of sewage and waste effluent and excessive soil erosion so that the water will be suitable for swimming, boating, shore recreation, and safe for all species of fish life with favorable conditions prevailing for their propagation.

APPENDIX I. (Continued)

Criteria: The water quality shall be held in the normal natural condition of the stream, with nearly all samples falling within the following limits:

1. Coliform Group: MPN not to exceed 2,000 per 100 ml.
2. pH: Range between 6.5 and 8.5.
3. D. O.: Monthly median not less than 6.5 ppm, with no D. O. below 4.0 ppm.
4. Turbidity: After opportunity for good mixing in the River, turbidity of the stream should not be appreciably changed.
5. Other Conditions: There shall be no oil, floating solids, settleable solids, or sludge deposits attributable to sewage, industrial wastes, or other wastes. There shall be no toxic wastes, deleterious substances, colored or other wastes or heated liquids, taste or odor producing substances, either alone or in combinations, in sufficient amounts to be injurious to fish life or to make the waters unsafe for swimming or shore recreation.

## SECTION IV

## POTOMAC RIVER: KEY BRIDGE TO FORT WASHINGTON

Objective: To reduce the quantity of combined sewage discharged, and to control the quality of waste effluents by effective treatment so as to make the water suitable for boating, shore recreation, industrial water supply and safe for the passage of all species of fish, with favorable conditions prevailing for the propagation of the hardier types.

Criteria: The water quality shall be maintained so that the results of most of the samples fall within the following limits:

1. Coliform Group: MPN not to exceed 10,000 per 100 ml.
2. pH: Range between 6.5 and 8.5.

APPENDIX IV. (Continued)

## B. SHENANDOAH RIVER AT BERRYVILLE, VIRGINIA

### 2. Critical Mass Flow Rates

| Item | Units | Critical Month | High (H) or Low (L) | Minimum | Mean | Maximum | Coef. of Var.%** | No. Observations for Critical Month |
|---|---|---|---|---|---|---|---|---|
| D.O. | lbs/day (1,000's) | Aug. | L | 12 | 22 | 47 | 59 | 7 |
| B.O.D.$_5$ | lbs/day (1,000's) | Mar. | H | 9 | 140 | 380 | 141 | 3 |
| C.O.D. | lbs/day (1,000's) | Annual | H | 39 | 880 | 2,200 | 113 | 8 |
| Coliform Bacteria | MF/day ($10^{12}$'s) | Mar. | H | 38 | 2,600* | 26,000 | 9* | 5 |
| Total Beta Radio-activity | uc/day (1,000's) | Mar. | H | 177 | 1,640 | 4,280 | 98 | 5 |
| Chloride | lbs/day (1,000's) | Mar. | H | 110 | 300 | 610 | 52 | 10 |
| Total Alkalinity | lbs/day (1,000's) | July | L | 28 | 41 | 800 | 48 | 8 |
| Hardness | lbs/day (1,000's) | Mar. | H | 1,820 | 5,290 | 12,600 | 60 | 11 |
| Total Dissolved Solids | lbs/day (1,000's) | Mar. | H | 3,050 | 7,040 | 17,000 | 60 | 10 |
| Sulfate | lbs/day (1,000's) | Mar. | H | 550 | 1,200 | 2,400 | 59 | 8 |
| Phosphate | lbs/day (1,000's) | Jan. | H | 0 | 4 | 25 | 265 | 7 |

* Geometric

Coefficient of Variation equals standard deviation divided by the mean.

## APPENDIX IV. (Continued)

### C. POTOMAC RIVER AT GREAT FALLS, MARYLAND

### 1. Critical Concentrations

| Item | Units | Critical Month | High (H) or Low (L) | Minimum | Mean | Maximum | Coef. of Var.%** | No. Observations for Critical Month |
|---|---|---|---|---|---|---|---|---|
| D.O. | mg/1 | July | L | 3.0 | 5.9 | 7.6 | 18 | 22 |
| D.O. | % sat. | July | L | 34 | 73 | 94 | 21 | 22 |
| Temp. | $^{o}C$. | July | H | 21 | 25.9 | 33.3 | 14 | 23 |
| B.O.D.$_5$ | mg/1 | Feb. | H | 1.6 | 3.3 | 8.6 | 59 | 16 |
| C.O.D. | mg/1 | Feb. | H | 5 | 22 | 67 | 72 | 15 |
| pH | --- | July | H | 7.9 | 8.4* | 9 | 2* | 21 |
| Coliform Bacteria | MF/100 ml | Mar. | H | 140 | 3,900* | 55,000 | 15* | 15 |
| $NH_3$-N | mg/1 | Jan. | H | 0.1 | 0.2 | 0.3 | 44 | 20 |
| Color | Platinum | June | H | 3 | 14 | 100 | 148 | 20 |
| Turbidity | Jackson Candle | Jan. | H | 9 | 83 | 430 | 155 | 21 |

---

* Geometric

** Coefficient of Variation equals standard deviation divided by the mean.

## APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Seneca Creek | 133.9 | | | | |
| Weinschel Engineering Co. | | Plating | 1,200 | Neutralization & Oxidation | |
| Carderock, Md. | | | | | |
| David Taylor Model Basin | 121.7 | 1,600 | 130,000 | Secondary | |
| Little Falls Branch | 116.3 | | | | |
| Maloney Concrete Co. | | Concrete Truck Washing | 10,000 | Settling | |
| Washington Petroleum | | Oil-drum Cl. | | | |
| Dalecarlia Water Filtration Plant | 116.1 | Filter Wash | 1,800,000 | Chlorination | |
| Rock Creek | 111.9 | | | | |
| Tributary | | | | | |
| Rockville, Md. | | | | | |
| H. & D. Metro Ford Tractor Co. | 1.7 | Tractor Cleaning | | Settling & Oil Removal | |
| Tributary | 13.9 | | | | |
| Chevy Chase, Md. | | | | | |
| Contee Sand & Gravel Co. | 1.1 | Concrete Truck Wash, Asphalt Stack Wash | 5,000 | Settling & Oil Removal | |
| District of Columbia West Heating Plant | | Cooling Water | 225,000 | Retention, Dilution | None |
| | | Boiler Blowdown, Softening | 225,000 | None | None |

APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Arlington, Va. | | | | | |
| Heating and Sewage Treatment Plants | | Sanitary | 2,000,000 | Secondary | 1,500 |
| (Pentagon, etc.) | | Cooling Water | | None | None |
| Anacostia River | 107.8 | | | | |
| Northeast Branch | 8.6 | | | | |
| Indian Creek | 3.6 | | | | |
| Muirkirk, Md. | | | | | |
| Mineral Pigments Corp. | | Pigments, chrom. | 200,000 | Oxid., setl. | None |
| Branchville, Md. | | | | | |
| A. H. Smith Sand & Gravel Co. | | Sand & Gravel Wash | 1,400,000 | Settling | None |
| Paint Branch | 3.6 | | | | |
| Whiteoak, Md. | | | | | |
| U. S. Naval Ordnance Lab. | | 3,000 | 110,000 | Primary | |
| | | Cooling Water | 160,000 | None | None |
| Wm. H. McCeney Co. | | Sand & Gravel Wash | 460,000 | Settling | None |
| Tributary | | | | | |
| Hyattsville, Md. | | | | | |
| Lustine Chevrolet Co. | | Engine Cl. | | Oil Seprtn. | |
| District of Columbia | | | | | |
| PEPCO Benning Generating Station | | Cooling Water | 154,520,000 | None | None |
| Potomac Sand & Gravel Co. | | Sand & Gravel Wash | | Settling | None |
| PEPCO Buzzard Point Generating Sta. | | Cooling Water | 109,169,000 | None | None |

## APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Fourmile Run (Va.) | 106.9 | | | | |
| Arlington County, Va. | 0.7 | 185,000 | 17,400,000 | Primary | 23,000 |
| District of Columbia | | | | | |
| Office of Naval Research | 105.4 | Cooling Water | 184,000 | None | None |
| | | Radioactive | 6,600 | Holding | None |
| Blue Plains Sewage Treatment Plant (District of Columbia Water Pollution Control Plant) | 105.4 | 1,400,000 | 215,000,000 | Secondary | 80,300 |
| Alexandria, Va. | | | | | |
| PEPCO Generating Station | | Cooling Water | 315,609,000 | None | None |
| Oxon Run | 104.6 | | | | |
| Hillside, Md. | | | | | |
| Washington Sand & Gravel Co. | | Sand & Gravel Wash | | Settling | None |
| Hunting Creek (Va.) | 103.2 | | | | |
| Cameron Run | 1.4 | | | | |
| Back Lick Run | | | | | |
| Springfield, Va. | | | | | |
| Virginia Sand & Gravel Co. | | Sand & Gravel Wash | 1,000,000 | Settling | None |
| Alexandria, Va. | | 138,000 | 13,200,000 | Secondary | 4,500 |
| Fairfax County Sanitary District #1 | | | | | |
| Westgate Plant | | 90,000 | 9,600,000 | Intermediate | 11,700 |
| Broad Creek | 100.4 | | | | |
| Henson Creek | 3.2 | | | | |
| Camp Springs, Md. | | | | | |
| Buffalo Sand & Gravel Co. | 6.1 | Sand & Gravel Wash | 500,000 | Settling | None |

## APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Piscataway Creek | 97.2 | | | | |
| Tinkers Creek | 4.4 | | | | |
| Meetinghouse Branch | 7.9 | | | | |
| Andrews AFB Plant #1 | | Sanitary | 700,000 | Secondary | |
| Paynes Branch | 7.9 | | | | |
| Andrews AFB Plant #4 | | Sanitary | | Secondary | |
| Clinton, Md. | | | | | |
| Inland Materials, Inc. | | Sand & Gravel Wash | | Settling | None |
| Tributary | | | | | |
| Clinton, Md. | | | | | |
| Country Club Cleaners | | Laundry & Dry Cleaning | | Secondary | |
| Fort Washington Estates | | | 100,000 | Secondary | 100 |
| Little Hunting Creek (Va.) | 95.8 | | | | |
| Fairfax County Sewage Treatment Plant | 1.2 | 11,000 | 2,200,000 | Secondary | 450 |
| Dogue Creek (Va.) | 93.5 | | | | |
| Fairfax County Sewage Treatment Plant | | 8,000 | 1,100,000 | Secondary | 340 |
| Fort Belvoir (USAR) Plant #2 | | Sanitary | 1,450,000 | Secondary | 170 |
| | | Cooling Water | 7,500,000 | None | None |
| Gunston Cove (Va.) | 91.3 | | | | |
| Accotink Creek | 2.0 | | | | |
| Fairfax, Va. | | 13,600 | 1,400,000 | Secondary | 350 |

APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Gunston Cove (Va.) (Continued) | | | | | |
| Pohick Creek | 1.6 | | | | |
| Pohick Estates | | | 13,000 | Secondary | 10 |
| Fort Belvoir (USAR) Plant #1 | | 3,700 | 312,000 | Secondary | 50 |
| Potomac Sand & Gravel Co. (Mobile Barge) | | Sand & Gravel Wash | | Settling | None |
| | | Dredging | | Settling | None |
| Pomonkey Creek | 89.0 | | | | |
| North Indian Head Estates, Md. | | 170 | 13,000 | Secondary | 4 |
| Potomac Heights, Md. | | 2,700 | 120,000 | Primary | 300 |
| Indian Head, Md. | | 1,200 | 96,000 | Primary | 130 |
| Occoquan Bay (Va.) | 83.3 | | | | |
| Occoquan Creek | | | | | |
| Broad Run | | | | | |
| Warrenton, Va. | | | | | |
| Lee-Hi Motel | | | | Secondary | |
| Gainesville, Va. | | | | | |
| Lakeview Estates | | | | Secondary | |
| Bristow, Va. | | | | | |
| Linton Hall School | | 400 | | Primary | 40 |
| Cedar Run | | | | | |
| Camp Upshur (U. S. Marine Corps) | | Filter Backwash (summer) | 2,000 | None | None |
| | | Sanitary (summer) | 94,000 | Secondary | |

## APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Occoquan Bay (Va.) (Continued) | | | | | |
| Bull Run | | | | | |
| Yorkshire, Va. | | | | | |
| Yorkshire Elementary School | | | | Secondary | |
| Manassas, Va. | | 3,560 | 400,000 | Secondary | 90 |
| Manassas Regional High School | | 440 | 10,000 | Secondary | |
| Occoquan, Va. | | | | | |
| Woodbridge S. D. Plant | | Sanitary | 100,000 | Secondary | |
| Massey Creek | 3.6 | | | | |
| Giles Run | | | | | |
| Lorton Nike Site (USAR) | | 50 | 3,000 | Secondary | 1 |
| Marumsco Creek | 1.4 | | | | |
| Woodbridge S. D. Plant | | Sanitary | 340,000 | Secondary | |
| Farm Creek | 0.2 | | | | |
| Woodbridge S. D. Lynwood - Featherstone Plant | | Sanitary | | Secondary | |
| Indian Head, Md. | | | | | |
| U. S. Naval Propellant Plant | | | | | |
| - Housing, Jado, and Storage Areas | | Sanitary | 255,000 | Primary | |
| - Industrial Area | | | 380,000 | None | |
| Neabsco Creek (Va.) | 82.4 | | | | |
| M. G. Garber Trailer Park | | 240 | 23,000 | Secondary | 6 |
| Garfield High School | | 730 | 15,000 | Secondary | |
| Powells Creek (Va.) | | | | | |
| Freestone Point, Va. | | 50 | 5,000 | Secondary | 1 |

## APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Mattawoman Creek | 81.6 | | | | |
| Waldorf Nike Site (USAR) | | Sanitary | 2,400 | Secondary | |
| Waldorf, Md. | | | | | |
| Naval Research Lab. | | 20 | | Secondary | |
| Tributary | | | | | |
| Bryans Road, Md. | | | | | |
| Crazy Carryout & Laundromat | | Laundry | | Carb. Filter, Chlorination | |
| Indian Head, Md. | | | | | |
| U. S. Naval Propellant Plant - Industrial Area | | San. & Chem. | 20,000 | None | |
| Quantico U. S. Marine Corps Reservation, Va. | | Filter Wash Water | 90,000 | None | |
| VEPCO Possum Pt. Generating Station, Va. | 78.5 | Cooling Water | | None | None |
| Quantico Creek (Va.) | 78.2 | | | | |
| Tributary | | | | | |
| Washington Reid Elem. School | | | | Secondary | |
| Dumfries Triangle, Va. (2 plants) | | 1,400 | 140,000 | Secondary | 35 |
| Dumfries School, Va. | | Sanitary | | Secondary | |
| Tributary | | | | | |
| Melrose Gardens Subdivision, Va. | | 1,200 | 120,000 | Secondary | 30 |
| Quantico U. S. Marine Corps Reservation | | | | | |
| - Post Docks | | 20 | 400 | None | |
| - Main Sewage Treatment Plant | | Sanitary | 1,390,000 | Secondary | |
| - Vehicle Wash Racks | | Vehicle Wash | 10,000 | None | |

APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Chopawamsic Creek (Va.) | 76.1 | | | | |
| Quantico U. S. Marine Corps Reservation | | | | | |
| Brown Field (Summer) | | Sanitary | 86,400 | Primary | |
| Tank Creek (Va.) | 74.7 | | | | |
| Quantico U. S. Marine Corps Reservation | | | | | |
| Midway Island (Housing) | | Sanitary | 62,000 | Secondary | |
| Aquia Creek (Va.) | 69.3 | | | | |
| Beaverdam Run | | | | | |
| Quantico U. S. Marine Corps Res. | | | | | |
| - Rifle Range | | | 60,000 | Secondary | |
| Garrisonville, Va. | | | | | |
| Aquia Mobile Park | | 100 | 10,000 | Lagoon | |
| Camp Barrett (U. S. Marine Corps) | | Sanitary | 164,500 | Secondary | |
| | | Filter Wash Water | 7,500 | None | |
| Potomac Creek (Va.) | 66.9 | | | | |
| Accakeek Creek | | | | | |
| Claiborne Creek | | | | | |
| Stafford High School | | | | Secondary | |
| Port Tobacco River | 53.5 | | | | |
| Port Tobacco Creek | | | | | |
| Ia Plata, Md. | | 1,400 | 110,000 | Secondary | |
| Upper Machodoc Creek (Va.) | 45.0 | | | | |
| Dahlgren, Va. | | | | | |
| U. S. Naval Weapons Lab. | | 2,800 day<br>1,000 night | 350,000 | Secondary | |
| Monroe Bay (Va.) | 39.8 | | | | |
| Colonial Beach, Va. | | 2,500 | 250,000 | Primary | 330 |

## C. POTOMAC RIVER AT GREAT FALLS, MARYLAND

### 1. Critical Concentrations (Continued)

| Item | Units | Critical Month | High (H) or Low (L) | Minimum | Mean | Maximum | Coef. of Var.%** | No. Observations for Critical Month |
|---|---|---|---|---|---|---|---|---|
| Total Beta Radioactivity | pc/1 | Nov. | H | 1 | 55 | 137 | 91 | 7 |
| Chloride | mg/1 | Oct. | H | 6 | 18 | 30 | 36 | 23 |
| Total Alkalinity | mg/1 | Mar. | L | 34 | 42 | 55 | 16 | 21 |
| Hardness | mg/1 | Oct. | H | 116 | 141 | 162 | 8 | 23 |
| Total Dissolved Solids | mg/1 | Oct. | H | 156 | 221 | 290 | 16 | 23 |
| Sulfate | mg/1 | Sept. | H | 26 | 61 | 130 | 51 | 21 |
| Phosphate | mg/1 | Apr. | H | 0 | 0.3 | 1.2 | 138 | 10 |

** Coefficient of Variation equals standard deviation divided by the mean.

APPENDIX IV. (Continued)

## C. POTOMAC RIVER AT GREAT FALLS, MARYLAND

### 2. Critical Mass Flow Rates

| Item | Units | Critical Month | High (H) or Low (L) | Minimum | Mean | Maximum | Coef. of Var.%** | No. Observations for Critical Month |
|---|---|---|---|---|---|---|---|---|
| D.O. | lbs/day (1,000's) | Aug. | L | 19 | 55 | 103 | 43 | 17 |
| B.O.D.$_5$ | lbs/day (1,000's) | Feb. | H | 49 | 530 | 4,200 | 203 | 16 |
| C.O.D. | lbs/day (1,000's) | Feb. | H | 120 | 4,600 | 33,000 | 200 | 15 |
| Coliform Bacteria | MF/day ($10^{12}$'s) | Mar. | H | 140,000 | 420,000* | 3,700,000 | 3* | 12 |
| $NH_3$-N | lbs/day (1,000's) | Feb. | H | 2 | 17 | 98 | 159 | 16 |
| Total Beta Radio-activity | uc/day (1,000's) | Apr. | H | 0 | 3,380 | 19,600 | 196 | 8 |
| Chloride | lbs/day (1,000's) | Mar. | H | 430 | 1,218 | 2,180 | 50 | 15 |
| Total Alkalinity | lbs/day (1,000's) | Aug. | L | 360 | 690 | 1,160 | 44 | 17 |
| Hardness | lbs/day (1,000's) | Mar. | H | 4,050 | 9,850 | 15,500 | 38 | 17 |
| Total Dissolved Solids | lbs/day (1,000's) | Mar. | H | 7,080 | 17,100 | 23,500 | 31 | 12 |

* Geometric

** Coefficient of Variation equals standard deviation divided by the mean.

## C. POTOMAC RIVER AT GREAT FALLS, MARYLAND

### 2. Critical Mass Flow Rates (Continued)

| Item | Units | Critical Month | High (H) or Low (L) | Minimum | Mean | Maximum | Coef. of Var.%** | No. Observations for Critical Month |
|---|---|---|---|---|---|---|---|---|
| Sulfate | lbs/day (1,000's) | Aug. | H | 240 | 430 | 570 | 24 | 17 |
| Phosphate | lbs/day (1,000's) | Apr. | H | 0 | 36 | 240 | 205 | 10 |

** Coefficient of Variation equals standard deviation divided by the mean.

## APPENDIX IV. (Continued)

### D. POTOMAC RIVER ESTUARY AT WASHINGTON, D.C. (MEMORIAL BRIDGE)

1. Critical Concentrations

| Item | Units | Critical Month | High (H) or Low (L) | Minimum | Mean | Maximum | Coef. of Var.%** | No. Observations for Critical Month |
|---|---|---|---|---|---|---|---|---|
| D.O. | mg/1 | July | L | 3.6 | 5.5 | 7.8 | 31 | 6 |
| D.O. | % sat. | July | L | 46 | 70 | 96 | 30 | 6 |
| Temp. | °C. | July | H | 26.5 | 27.8 | 29.1 | 4 | 6 |
| $B.O.D._5$ | mg/1 | Apr. | H | 1 | 1.6 | 2.4 | 39 | 5 |
| C.O.D. | mg/1 | Oct. | H | 22 | 34 | 67 | 42 | 8 |
| pH | --- | Nov. | H | 7.4 | 7.9* | 9.4 | 4* | 8 |
| Coliform Bacteria | MF/100 ml | July | H | 3,500 | 42,000* | 200,000 | 15* | 5 |
| $NH_3$-N | mg/1 | July | H | 0 | 0.5 | 0.7 | 59 | 6 |
| Color | Platinum | Feb. | H | 5 | 12 | 31 | 76 | 8 |
| Turbidity | Jackson Candle | Jan. | H | 25 | 150 | 490 | 113 | 7 |
| Total Beta Radio-activity | pc/1 | Aug. | H | 9 | 38 | 84 | 75 | 5 |

* Geometric

** Coefficient of Variation equals standard deviation divided by the mean.

## APPENDIX V. TABULATION OF MUNICIPAL AND INDUSTRIAL WASTE DISCHARGES IN THE POTOMAC RIVER BASIN OF MARYLAND

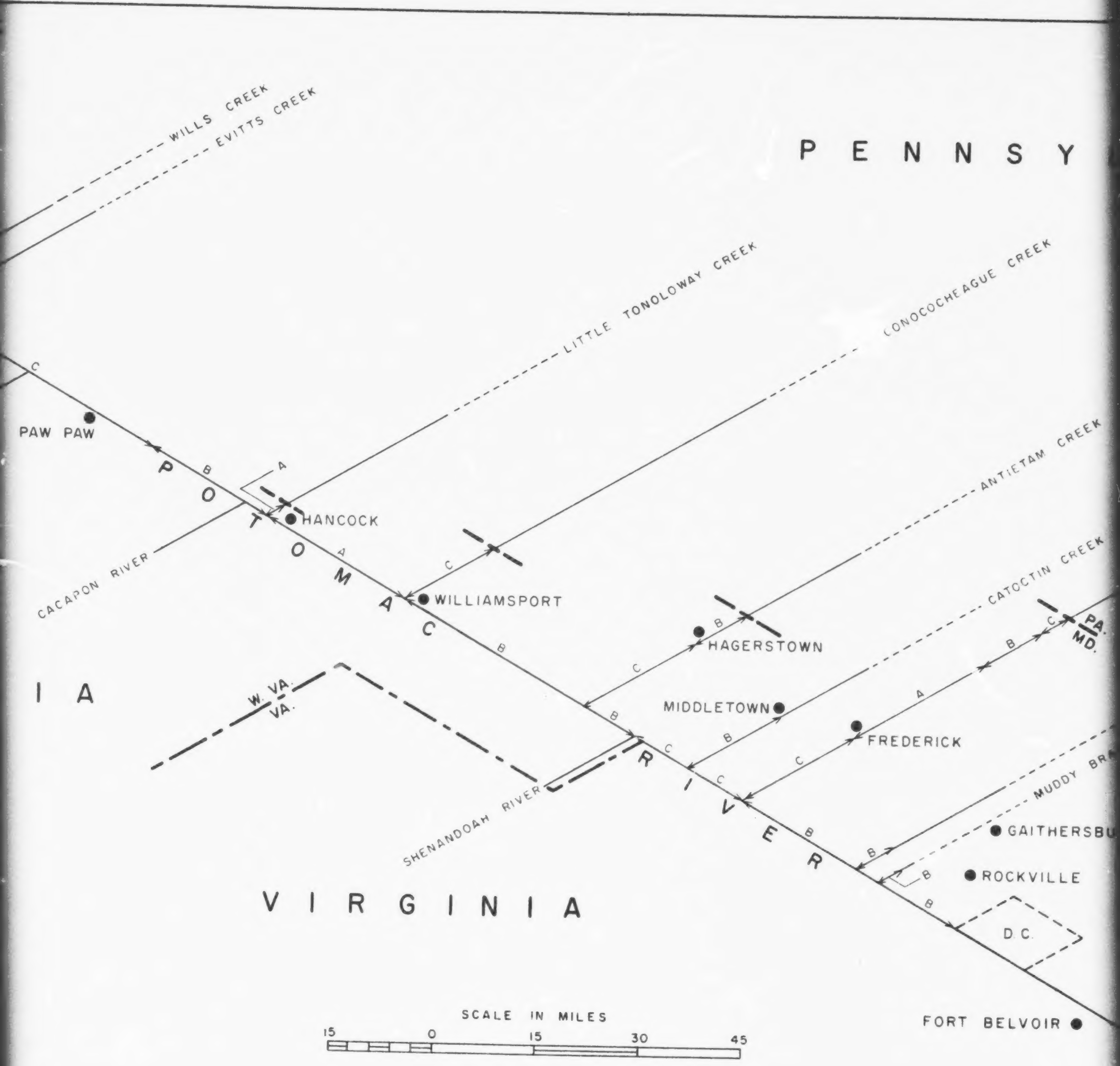
| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| POTOMAC RIVER | | | | | |
| North Branch Potomac River | 285.1 | | | | |
| Elk Run (W. Va.) | 91.6 | | | | |
| Henry, W. Va. | 0.1 | | | | |
| Alpine Coal Co.[a] | 1.0 | Wash Water | | Settling | |
| Buffalo Creek (W. Va.) | 86.4 | | | | |
| Bayard, W. Va.[b] | 0.1 | | | | |
| North Branch Coal Co. | 1.5 | Wash Water | | Settling | |
| Stony River (W. Va.) | 78.3 | | | | |
| Savage River | 53.5 | | | | |
| Luke, Md.[c] | 52.5 | | | | |
| W. Va. Pulp & Paper Co. | 52.5 | Pulp & Paper<br>Cooling & Lime | | None[c] | |
| Georges Creek | 51.4 | | | | |
| Frostburg, Md. | 15.7 | 4,000[d] | | None | 680[d] |
| Sandspring Run | 15.5 | | | | |
| Lotz Wholesale Meats Co. | 3.4 | | 1,000 | Settling | 2 |
| Dashiell Dairy | 11.2 | | | | |

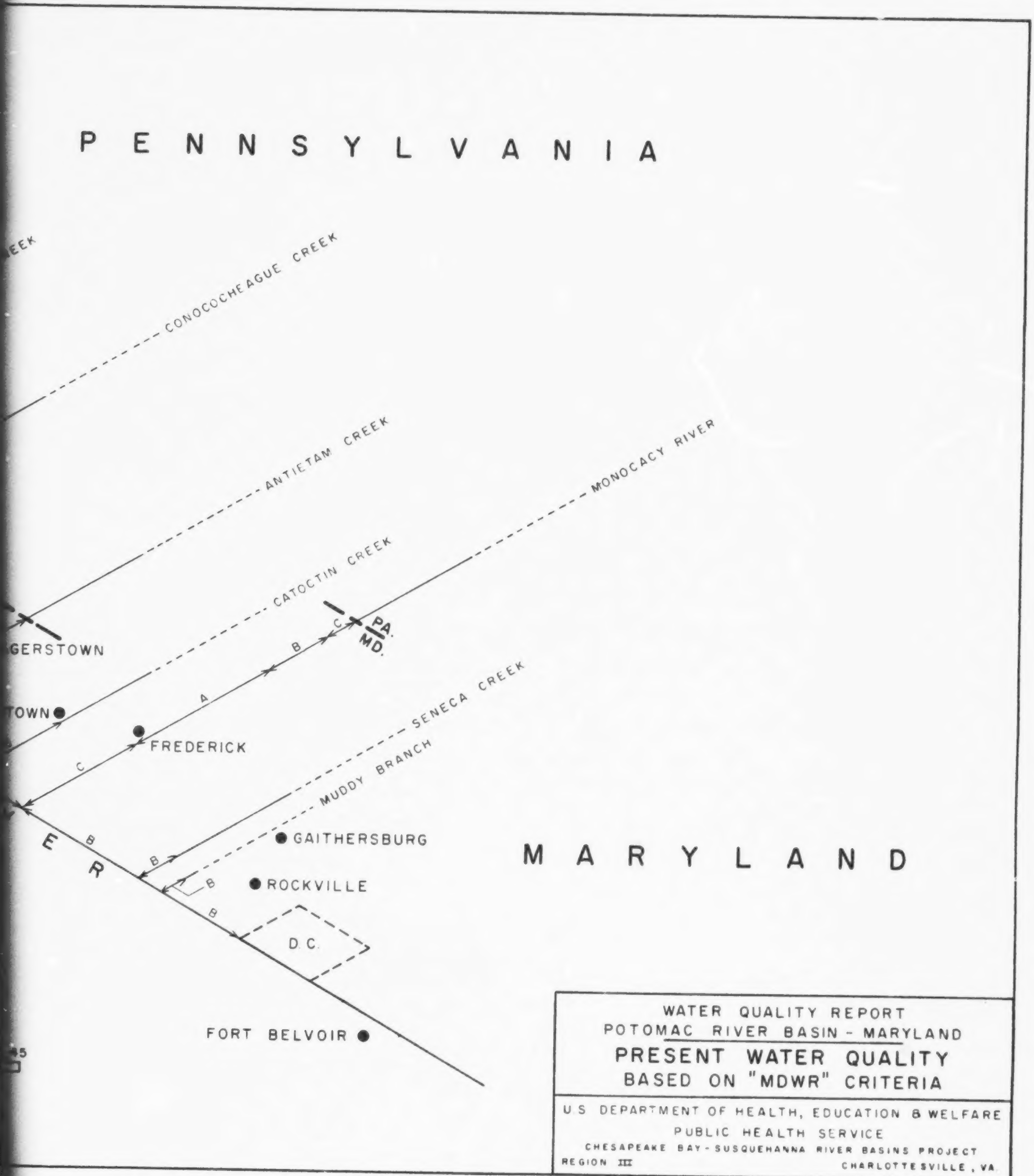
---

a. Part seepage to Deakin Run entering North Branch at River Mile 92.0.
b. Discharges of untreated or partially treated sewage from individual households.
c. Major portion of waste is treated at the Upper Potomac River Commission Waste Treatment Facility (45.9).
d. Part discharged to Wills Creek drainage area (see below).

## APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Piedmont, W. Va. | 51.2 | 2,400 | 190,000 | None | 410 |
| Westernport, Md. | 51.0 | | | | |
| Upper Potomac River Commission | 51.0 | Pulp and Paper | 17,200,000 | Secondary | |
| Keyser, W. Va. | 46.2 | 4,500 | 360,000 | Primary | 500 |
| Bel Air, Md. | 32.7 | 400 | 30,000 | Lagoon | 10 |
| Pinto, Md. | | | | | |
| Barton's Dairy | 32.6 | Dairy | | None | |
| Rocket Center, W. Va. | 32.5 | | | | |
| Allegany Ballistics Lab., Hercules Powder Co. | 32.5 | 2,000 | 100,000 | Secondary | 50 |
| Cresaptown, Md. | 29.5 | 3,500 | 280,000 | Primary | 390 |
| Mason's Dairy | 29.7 | Dairy | 35,000 | None | 20 |
| Amcelle, Md. | | | | | |
| Celanese Fibers Co. | 28.8 | 3,000 | | | |
| | | Processing | 1,950,000 | Lagoon | |
| | | Cooling | 40,000,000 | None | 15,000 |
| | | Sanitary | 50,000 | Lagoon | |
| Bowling Green, Md. | 25.0 | 2,250 | 180,000 | Primary | 250 |
| Kelly-Springfield Tire Co. | 23.4 | Cooling | 2,900,000 | None | |
| Potomac Edison Co. | 22.6 | Cooling | 675,000 | None | |


WILLS CREEK
EVITTS CREEK
PENNSY
LITTLE TONOLOWAY CREEK
CONOCOCHEAGUE CREEK
C
PAW PAW
P
B
A
ANTIETAM CREEK
O
HANCOCK
CACAPON RIVER
T
A
O
C
M
CATOCTIN CREEK
WILLIAMSPORT
A
C
B
B
C
PA.
MD.
HAGERSTOWN
B
I A
C
A
MIDDLETOWN
W. VA.
VA.
B
B
FREDERICK
R
C
C
C
I
MUDDY BRA
SHENANDOAH RIVER
V
B
GAITHERSBU
E
B
R
B
ROCKVILLE
B
VIRGINIA
D.C.
SCALE IN MILES
15
0
15
30
45
FORT BELVOIR

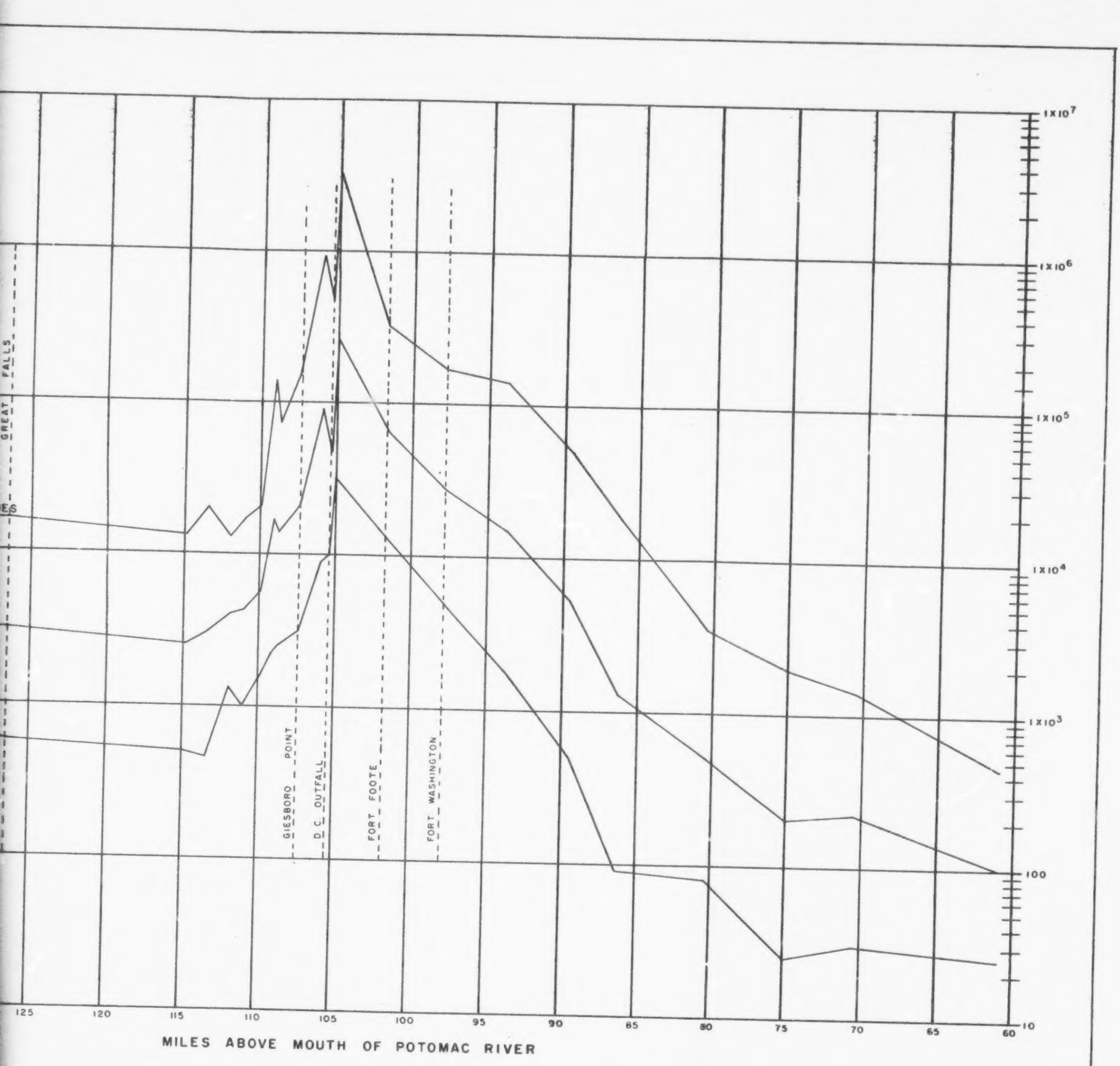


WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

**PRESENT WATER QUALITY**
**BASED ON "MDWR" CRITERIA**

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 17

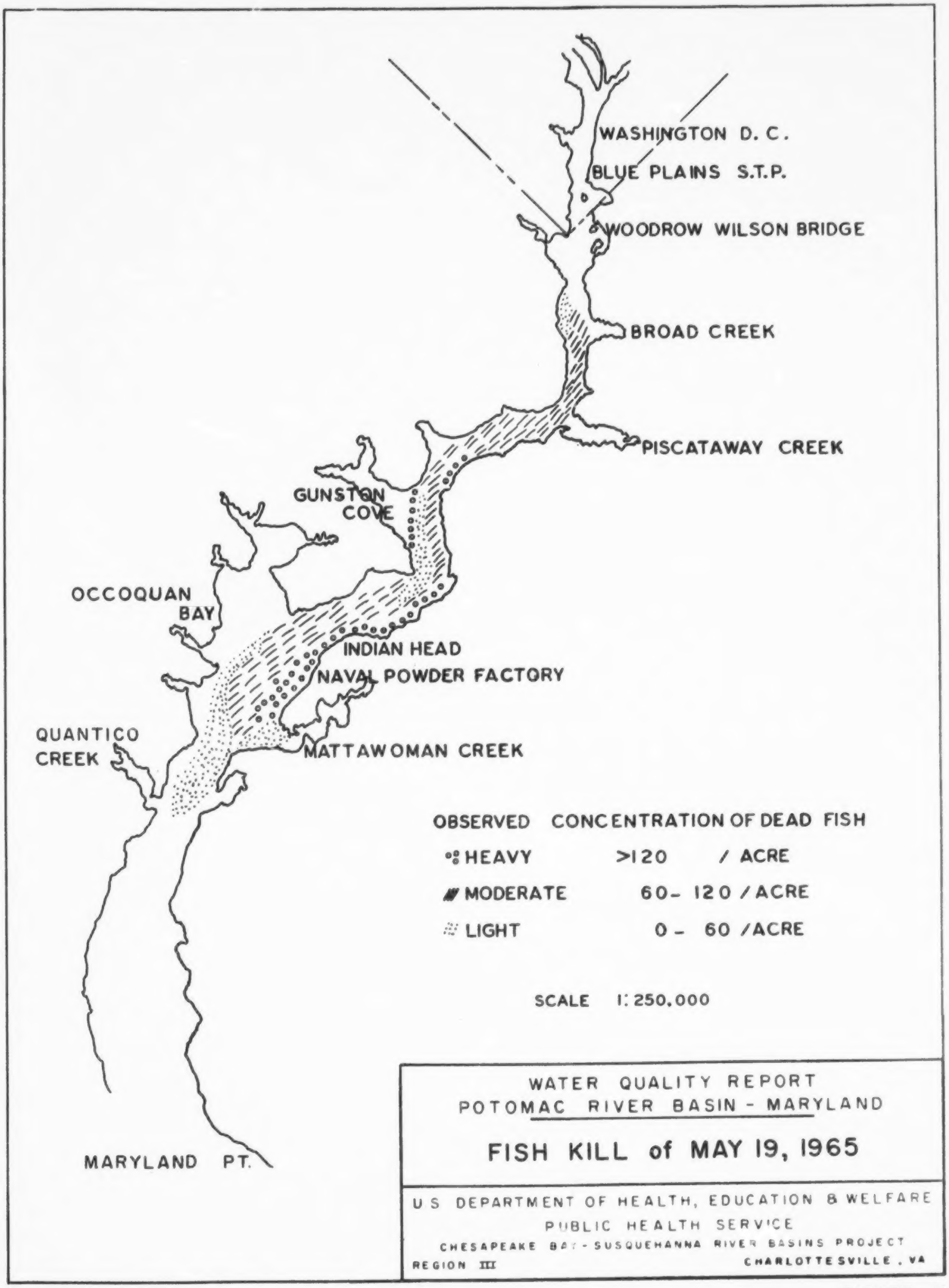


WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

**POTOMAC ESTUARY-COLIFORM CONC.
DEC-MAY, 1960-1964**

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY-SUSQUEHANNA RIVER BASINS PROJECT
REGION III
CHARLOTTESVILLE, VA.

FIGURE 10

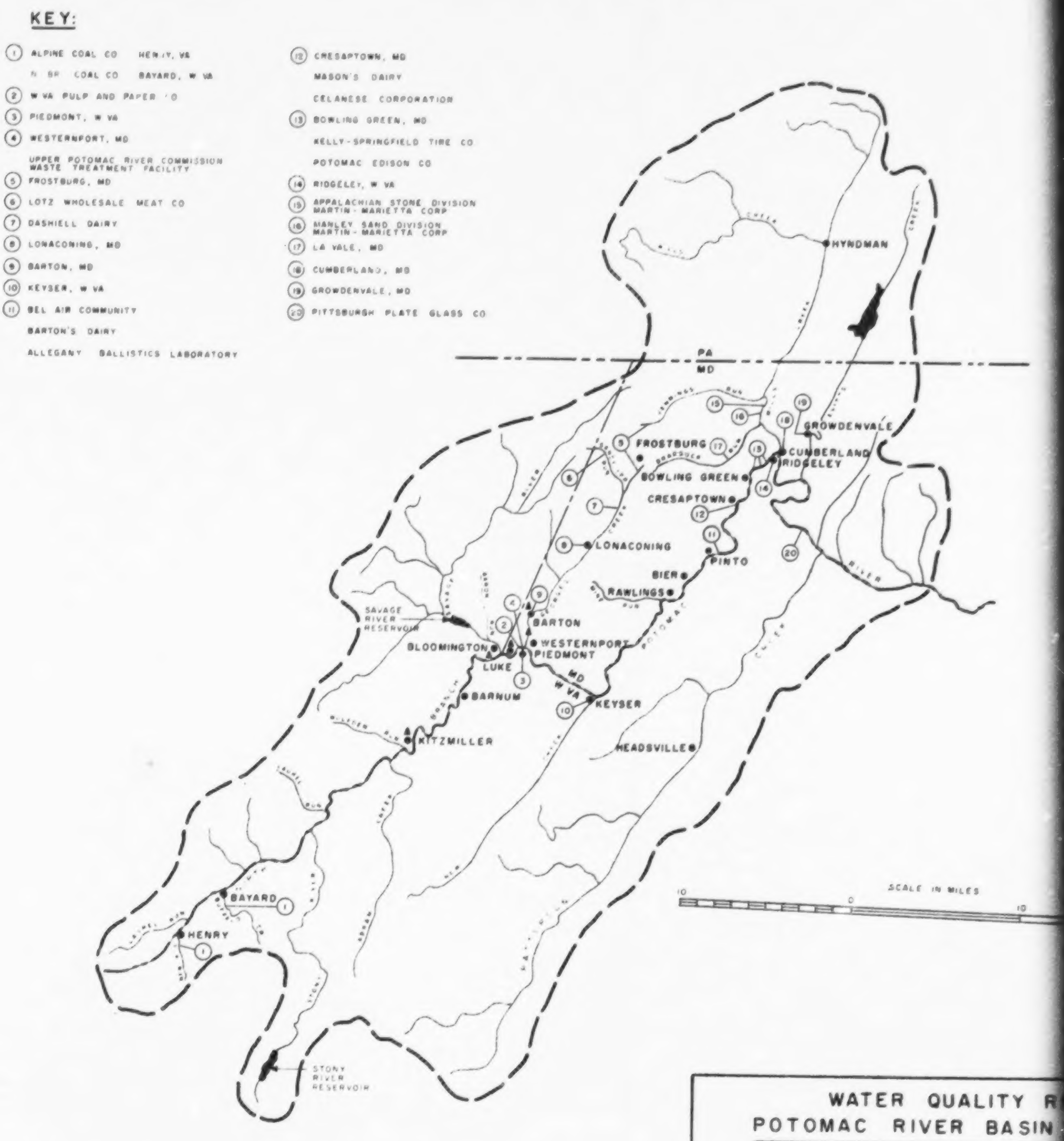


WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

FISH KILL of MAY 19, 1965

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III
CHARLOTTESVILLE, VA

FIGURE 11

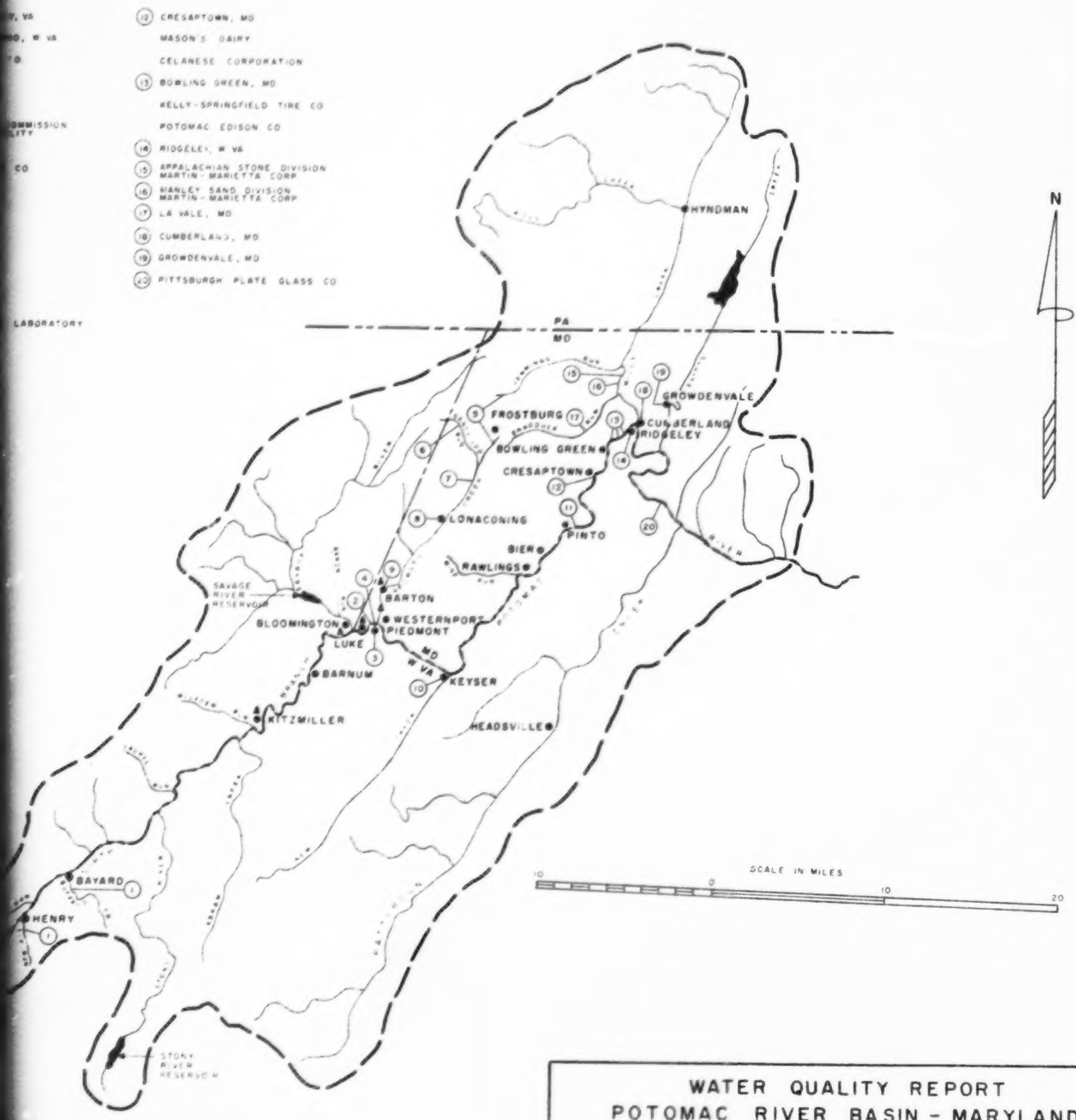


WATER QUALITY R
POTOMAC RIVER BASIN

MUN. & INDUS. WASTE

NORTH BRANCH - POTOM

U S DEPARTMENT OF HEALTH, EDU
PUBLIC HEALTH SER
CHESAPEAKE BAY-SUSQUEHANNA RIVE
REGION III



WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

## MUN. & INDUS. WASTE DISCHARGES

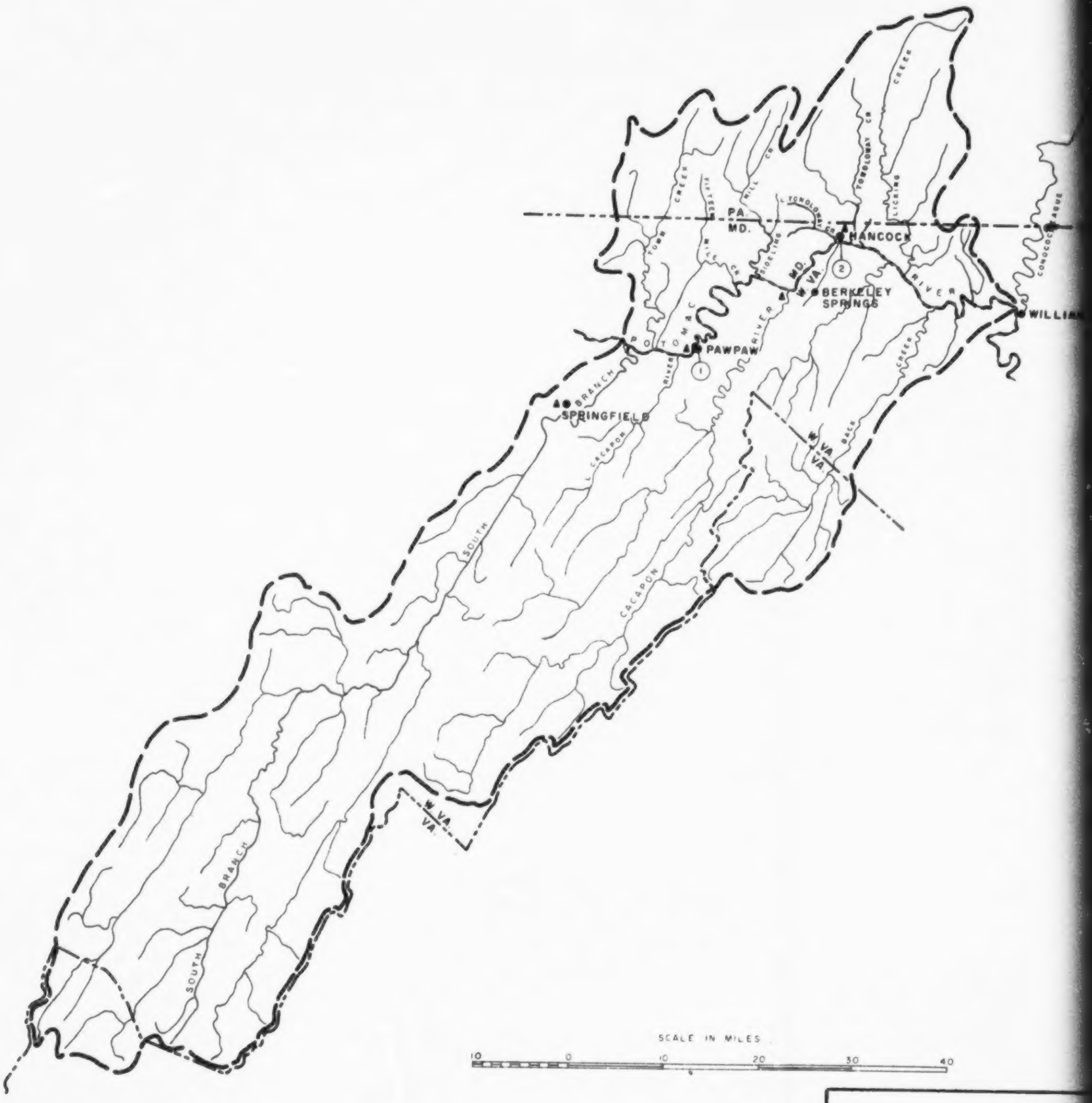
NORTH BRANCH - POTOMAC RIVER

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 12

**KEY:**

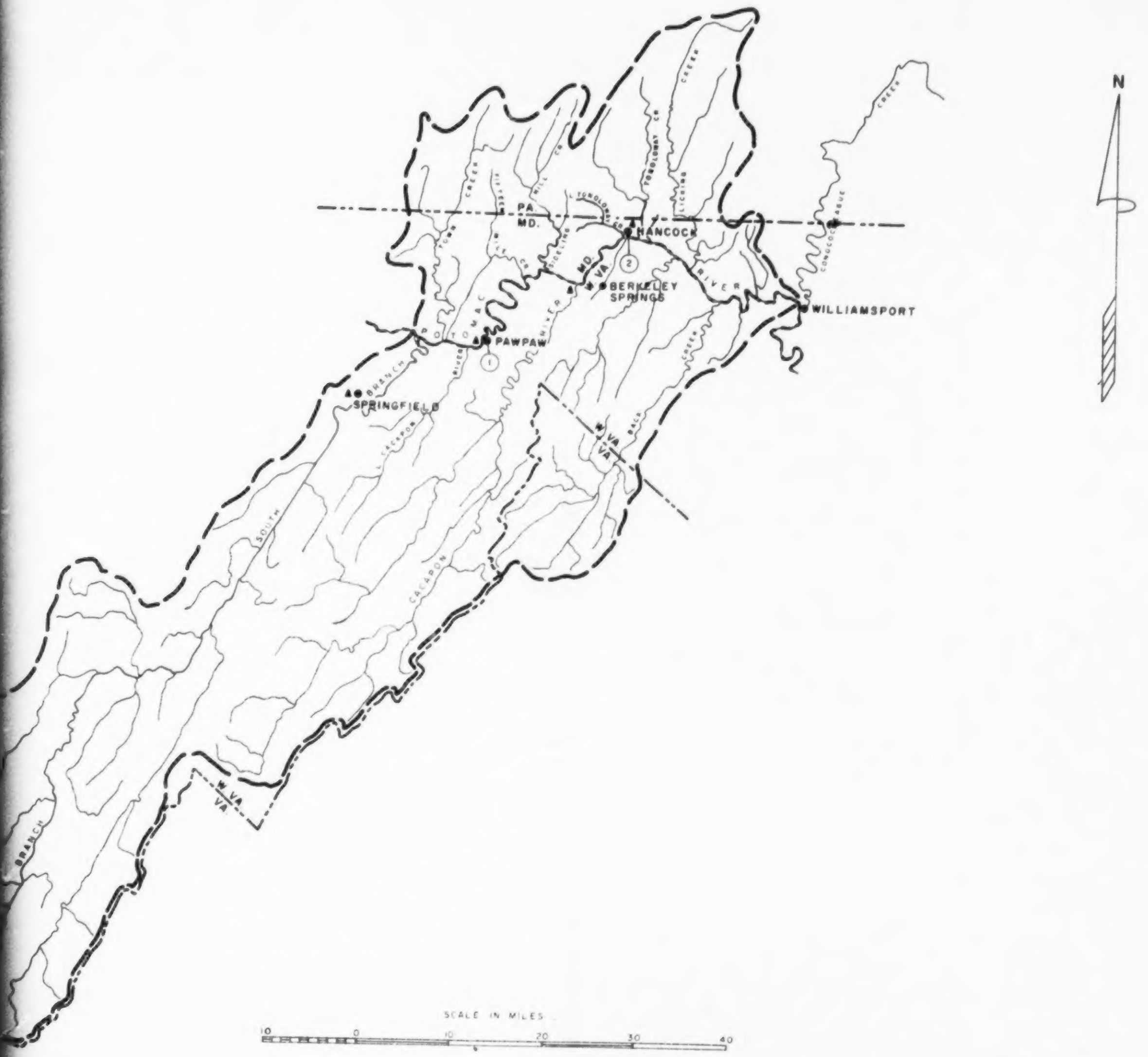
① PAW PAW, WEST VIRGINIA
② HANCOCK, MARYLAND



WATER
POTOMAC RI

MUN. & INDUS
POTOMAC RIVER
TO CONO

U.S. DEPARTMENT OF
PUBLIC
CHESAPEAKE BAY-SU
REGION III

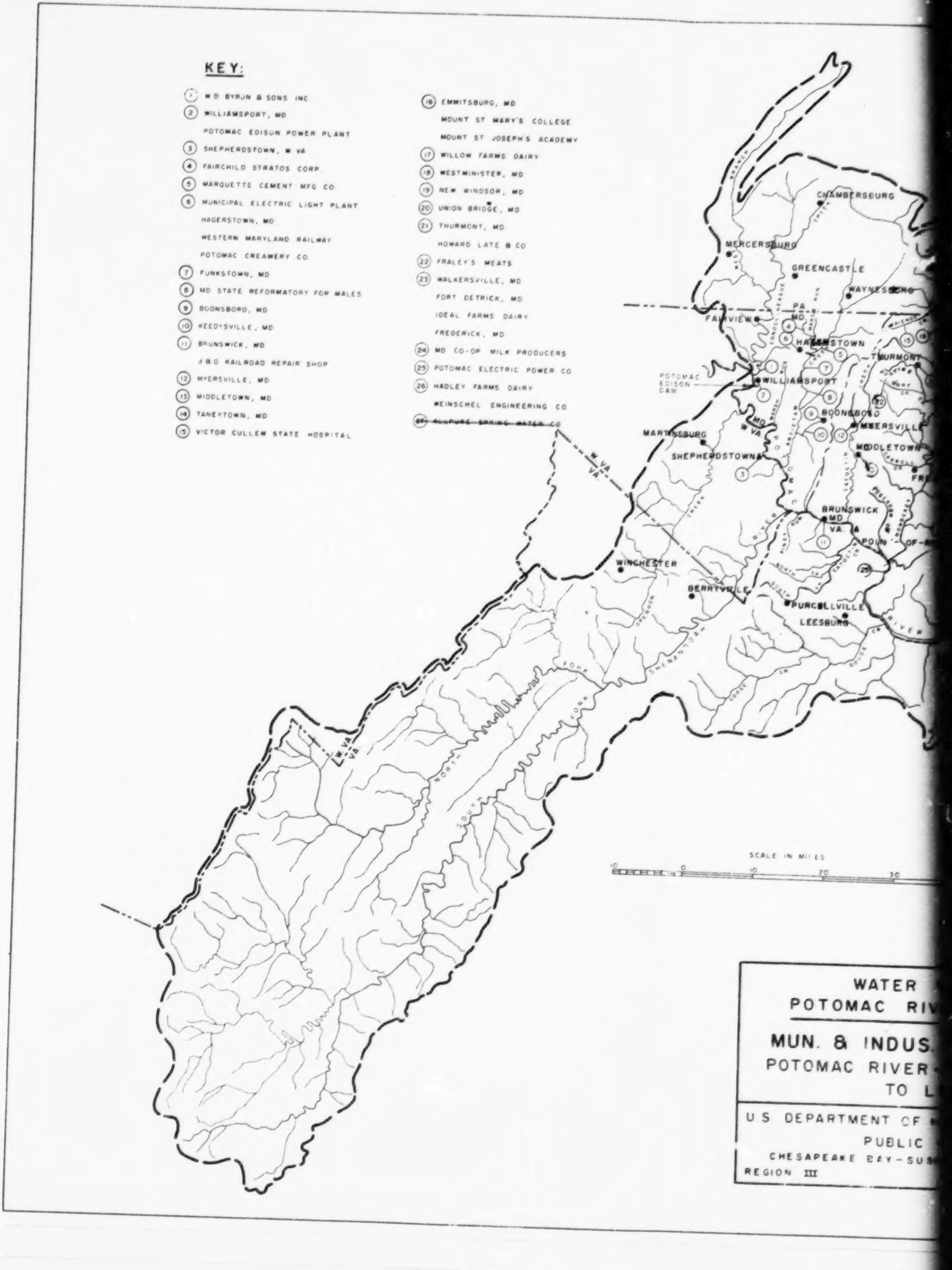


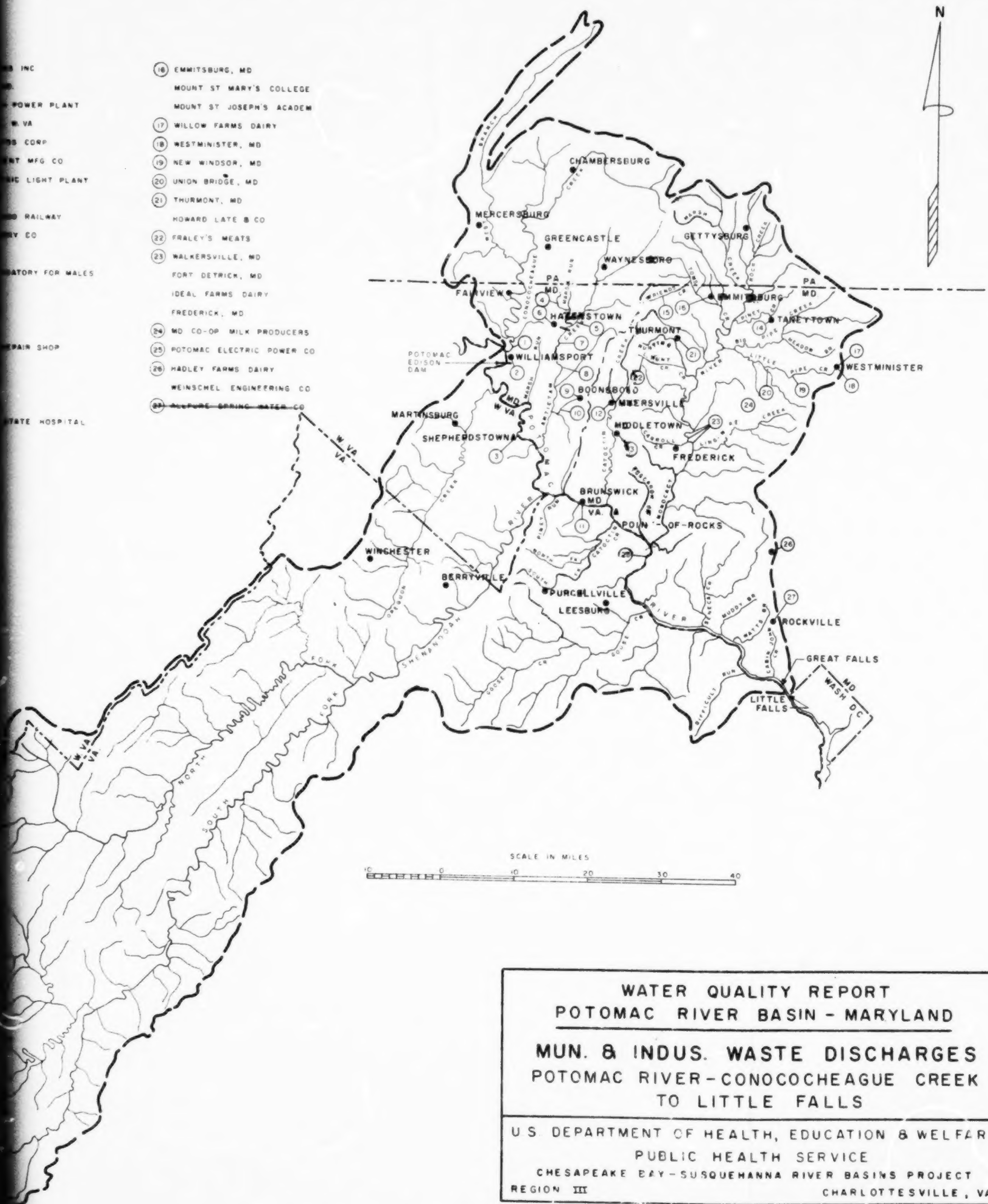
WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

## MUN. & INDUS. WASTE DISCHARGES
POTOMAC RIVER - SOUTH BRANCH POTOMAC
TO CONOCOCHEAGUE CREEK

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III
CHARLOTTESVILLE, VA.

FIGURE 13


KEY:
① W D BYRON & SONS INC
② WILLIAMSPORT, MD
POTOMAC EDISON POWER PLANT
③ SHEPHERDSTOWN, W VA
④ FAIRCHILD STRATOS CORP.
⑤ MARQUETTE CEMENT MFG CO
⑥ MUNICIPAL ELECTRIC LIGHT PLANT
HAGERSTOWN, MD
WESTERN MARYLAND RAILWAY
POTOMAC CREAMERY CO
⑦ FUNKSTOWN, MD
⑧ MD STATE REFORMATORY FOR MALES
⑨ BOONSBORO, MD
⑩ KEEDYSVILLE, MD
⑪ BRUNSWICK, MD
B & O RAILROAD REPAIR SHOP
⑫ MYERSVILLE, MD
⑬ MIDDLETOWN, MD
⑭ TANEYTOWN, MD
⑮ VICTOR CULLEN STATE HOSPITAL
⑯ EMMITSBURG, MD
MOUNT ST MARY'S COLLEGE
MOUNT ST JOSEPH'S ACADEMY
⑰ WILLOW FARMS DAIRY
⑱ WESTMINISTER, MD
⑲ NEW WINDSOR, MD
⑳ UNION BRIDGE, MD
㉑ THURMONT, MD
HOWARD LATE & CO
㉒ FRALEY'S MEATS
㉓ WALKERSVILLE, MD
FORT DETRICK, MD
IDEAL FARMS DAIRY
FREDERICK, MD
㉔ MD CO-OP MILK PRODUCERS
㉕ POTOMAC ELECTRIC POWER CO
㉖ HADLEY FARMS DAIRY
WEINSCHEL ENGINEERING CO
~~㉗ ALLPURE SPRING WATER CO~~
CHAMBERSBURG
MERCERSBURG
GREENCASTLE
WAYNESBORO
PA
MD
FAIRVIEW
HAGERSTOWN
THURMONT
POTOMAC EDISON DAM
WILLIAMSPORT
BOONSBORO
MYERSVILLE
MIDDLETOWN
MARTINSBURG
SHEPHERDSTOWN
MD
W VA
W VA
VA
BRUNSWICK
MD
VA.
WINCHESTER
BERRYVILLE
PURCELLVILLE
LEESBURG
W VA
VA
NORTH
SOUTH
FORK
SHENANDOAH
RIVER
POTOMAC
ANTIETAM
CATOCTIN
CONOCOCHEAGUE
OPEQUON
GOOSE CR
BRANCH
SCALE IN MILES
10
0
10
20
30
WATER
POTOMAC RIV
MUN. & INDUS.
POTOMAC RIVER
TO L
U S DEPARTMENT OF
PUBLIC
CHESAPEAKE BAY-SUS
REGION III



WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

**MUN. & INDUS. WASTE DISCHARGES**
POTOMAC RIVER-CONOCOCHEAGUE CREEK
TO LITTLE FALLS

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY-SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 14

# APPENDIX VII. RIVER MILEAGES IN THE POTOMAC RIVER ESTUARY:
# MARYLAND STATE PLANNING DEPARTMENT
# AND
# INTERSTATE COMMISSION ON THE POTOMAC RIVER BASIN

The River Mileages used in this report are those recently developed by the Maryland State Planning Department. The table below has been prepared to compare these mileages in the upper Potomac estuary with those of the Interstate Commission on the Potomac River Basin to assist in locating points under the two systems.

| Location | INCOPOT | Maryland State Planning Department |
|---|---|---|
| Point-of-Rocks | 163.0 | 159.4 |
| Great Falls | 125.6 | 126.5 |
| Little Falls (head of tide) | -- | 116.1 |
| Fletcher's Boat House | 104.5 | 114.8* |
| Three Sister's Island | 103.1 | 113.4* |
| Roosevelt Island | 101.6 | 111.9* |
| Memorial Bridge | 100.7 | 111.0 |
| Highway Bridge | 99.7 | 109.9 |
| Potomac Park | 99.1 | 109.1 |
| Hains Point | 98.3 | 108.3* |
| Giesboro Point | 97.4 | 107.4 |
| Above Sew. Treat. Plant | 96.1 | 106.0 |
| Opposite Sew. Treat. Plant | 95.6 | 105.4 |
| Below Sew. Treat. Plant | 95.3 | 105.1 |
| Woodrow Wilson Bridge | 94.4 | 103.4 |

## APPENDIX VII. (Continued)

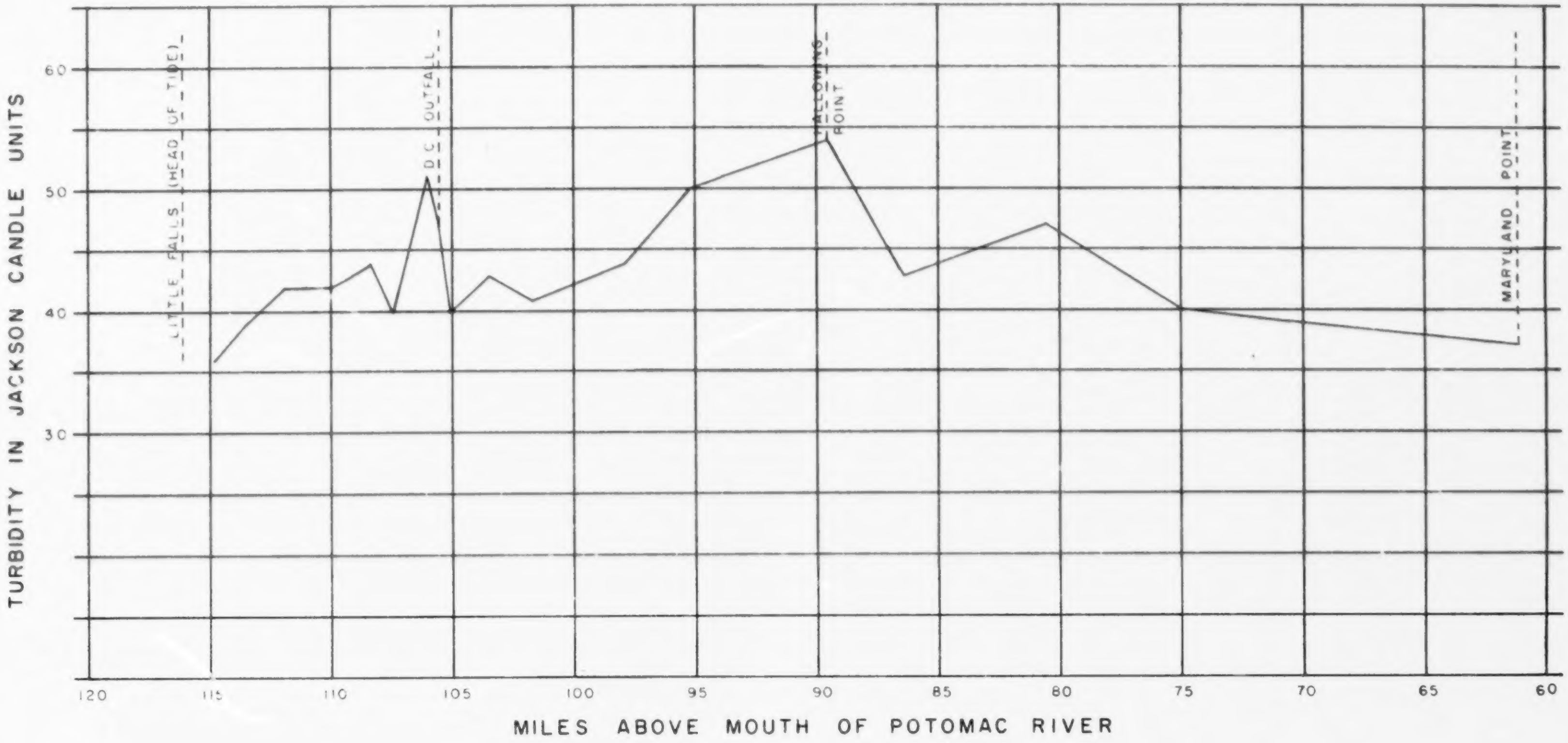
| Location | INCOPOT | Maryland State Planning Department |
|---|---|---|
| Fort Foote | 92.9 | 101.7 |
| Fort Washington | 89.0 | 97.8 |
| Mt. Vernon | 86.4 | 95.2 |
| Marshall Hall | 85.0 | 93.8 |
| Hallowing Point | 80.7 | 89.5 |
| Indian Head | 77.5 | 86.3* |
| Stump Neck | 72.7 | 80.4* |
| Sandy Point | 67.3 | 75.0* |
| Smith Point | 62.9 | 70.5* |
| Maryland Point | 57.3 | 61.0* |

---

* Calculated or estimated

# APPENDIX VIII

## FIGURES

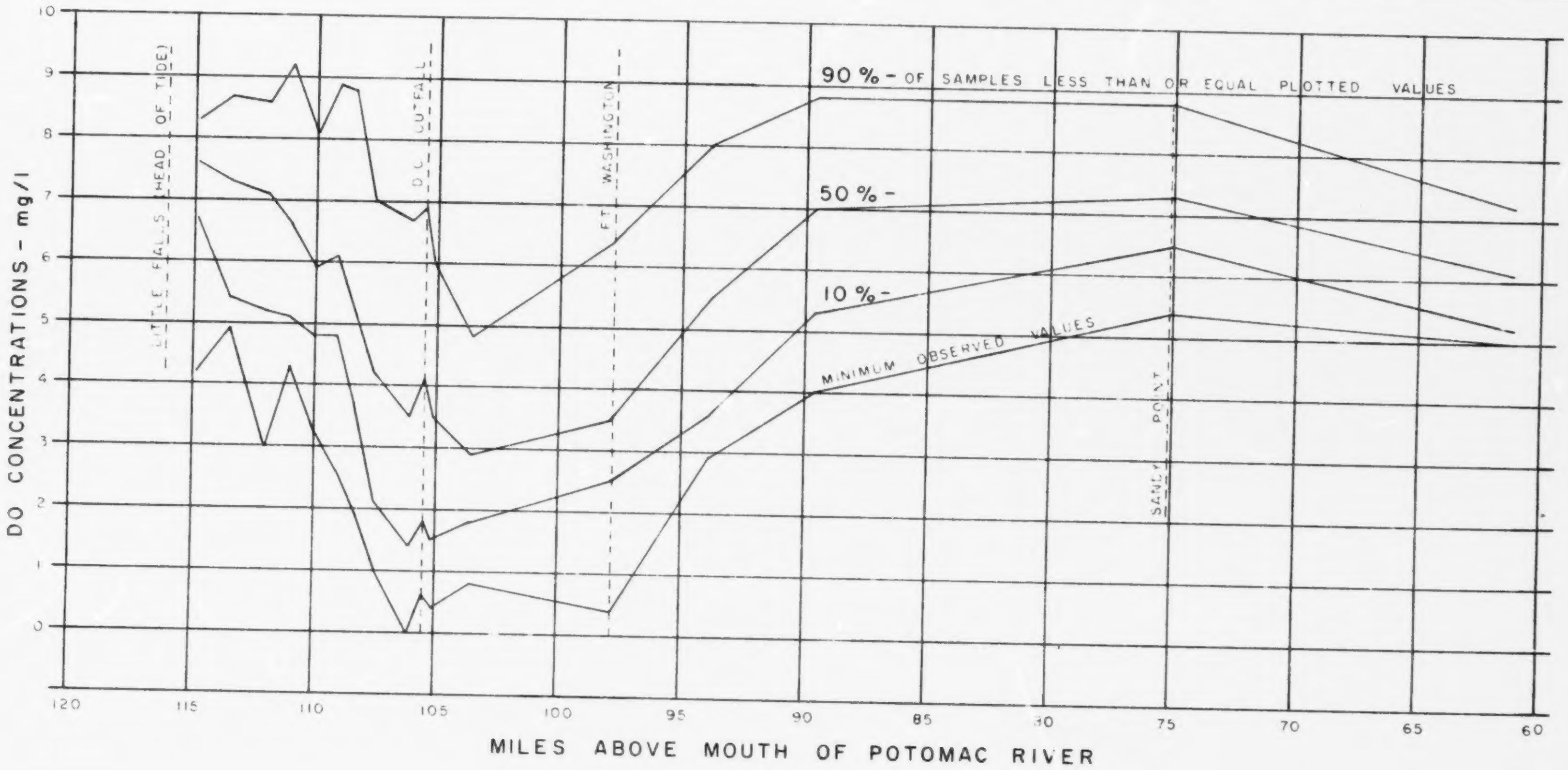


WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

## POTOMAC ESTUARY
## TURBIDITY vs RIVER MILE

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA

FIGURE 1

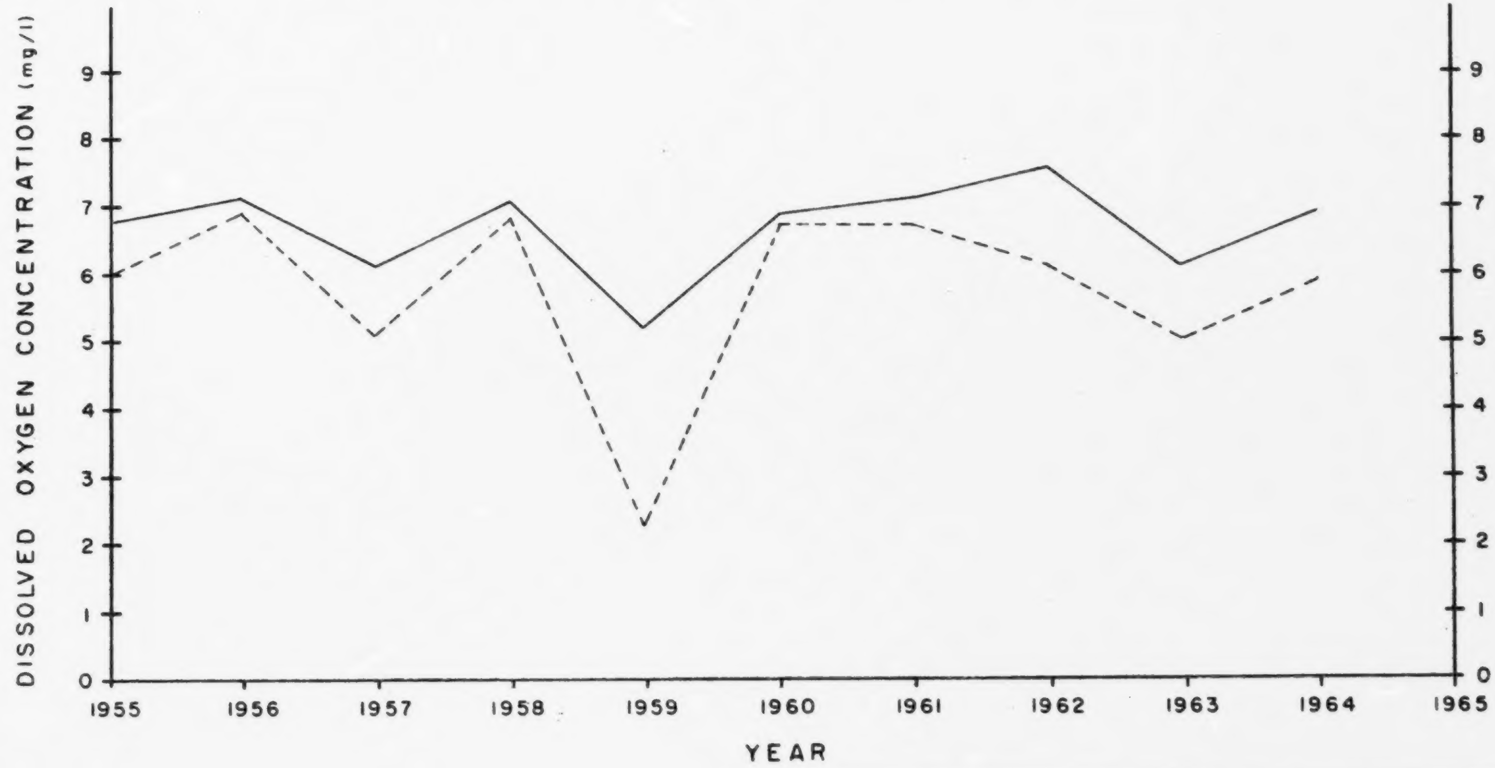


WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

POTOMAC ESTUARY - D.O. CONC.
JULY 15 - SEPT 15, 1960 - 1964

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA

FIGURE 2



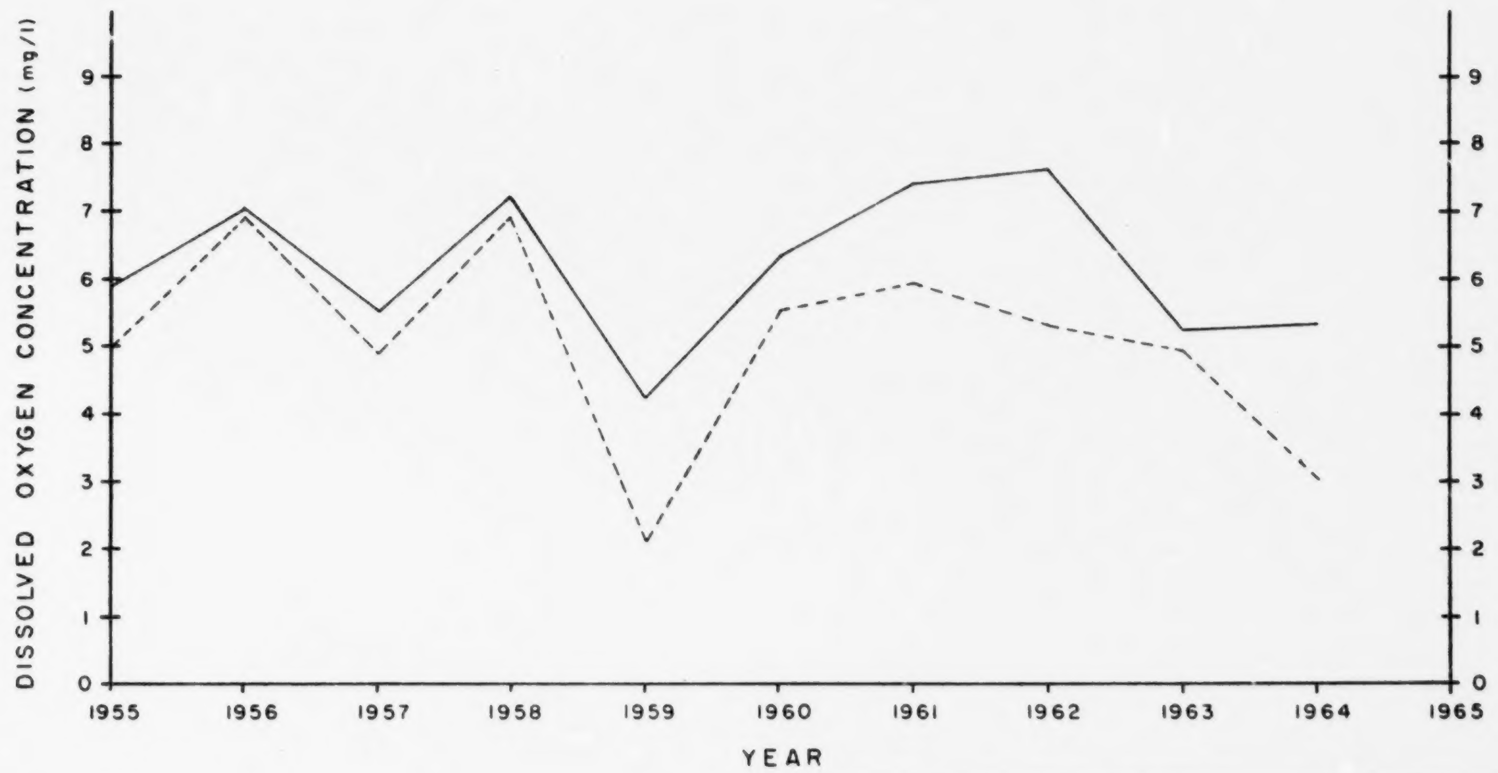
LEGEND:
- ——— MINIMUM CONSECUTIVE 28-DAY AVERAGE
- - - - - - MINIMUM SINGLE VALUE DURING 28-DAY PERIOD

WATER QUALITY REPORT
POTOMAC RIVER BASIN – MARYLAND

MIN. DISSOLVED OXYGEN CONC.
AT THREE SISTERS ISLAND
(RIVER MILE 113.4)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 3

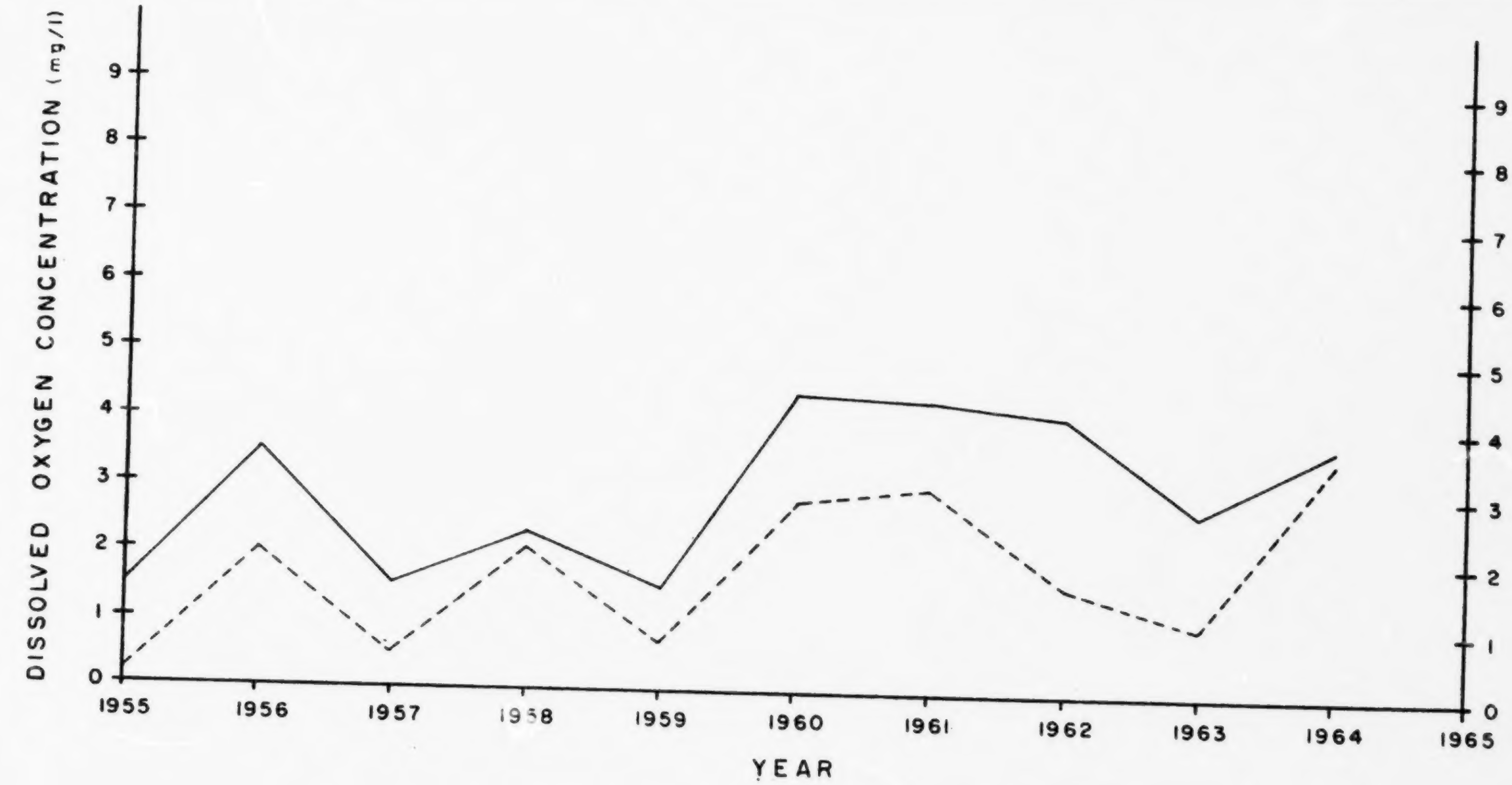


WATER QUALITY REPORT
POTOMAC RIVER BASIN – MARYLAND

## MIN. DISSOLVED OXYGEN CONC.
## AT ROOSEVELT ISLAND
## (RIVER MILE 111.9)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 4



WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

MIN. DISSOLVED OXYGEN CONC.
AT GIESBORO POINT
(RIVER MILE 107.4)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 5

## APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Wicomico River | 35.1 | | | | |
| Allens Fresh Run | | | | | |
| Zekiah Swamp | | | | | |
| Waldorf, Md. | | | | | |
| Waldorf Laundry | | Laundry | 7,000 | Settling | |
| East Coast Radio Trans. Station (USAR) | | Sanitary | 10,000 | Secondary | |
| Newport Run | | | | | |
| Gilbert Swamp Run | | | | | |
| So. Md. Correctional Camp | | 130 | 11,000 | Secondary | |
| Nomini Bay (Va.) | 28.7 | | | | |
| Nomini Creek | 1.9 | | | | |
| Cople-Montross Elem. School | | | | Secondary | |
| Breton Bay | 27.2 | | | | |
| Town Run | 7.0 | | | | |
| Leonardtown, Md. | 1.0 | 670 | 54,000 | Primary | 75 |
| Glebe Run | | | | | |
| Leonardtown Sand & Gravel Co. | | Sand & Gravel Wash | | Settling | None |
| Piney Point, Md. | | | | | |
| L. P. Steuart | | Bulk Oil Stg. (spillage) | | Catch pans | |
| Marina & Residences (Summer) | | 250 | | Primary | 30 |
| Piney Point Creek | | | | | |
| Piney Point Hotel (Summer) | | 250 | | Primary | 30 |

## APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Yeocomico River (Va.) | 12.7 | | | | |
| South Yeocomico River | 1.1 | | | | |
| Lodge Creek | 1.4 | | | | |
| Callao Elementary School | | | | Secondary & Lagoon | |
| St. Mary's River | 11.3 | | | | |
| St. Mary's City, Md. | | | | | |
| St. Mary's Jr. College | | 180 | 8,000 | Primary | |
| Naval Air Navigation & Electronics Project (Webster Field) | | 65 day | | Primary (part)<br>Secondary (part) | |
| Smith Creek | 9.9 | | | | |
| Ridge Md. | | | | | |
| G. I. Rupert Lore Seafood Co. | | Shellfish Shucking | | None | |
| Coan River (Va.) | 8.0 | | | | |
| Lake, Va. | | | | | |
| S. S. Headley Oyster Packer | | Shellfish Shucking | | | |

# APPENDIX VI. POTENTIAL FISHERY CLASSIFICATIONS OF STREAMS IN THE POTOMAC RIVER BASIN OF MARYLAND

by
U. S. Fish and Wildlife Service

## I. NORTH BRANCH POTOMAC RIVER

Headwaters to Savage River (43.0 miles)

The main stem of the North Branch in this sub-reach has been classified as Type 3P (Trout stream with observed pollution condition). This is a potential classification only. One long-time resident of Barnum, West Virginia, the site of the proposed Bloomington Reservoir, stated that no fish had been seen at that site for 35 years. Some of the small tributaries in Maryland are classified as Type 2 (Trout feeder), Type 3 (Trout stream), and Type 4 (Sucker stream).

Savage River to New Creek (7.8 miles)

Savage River in its headwaters and below Savage Reservoir has been classified as Type 2 (Trout feeder) and in other sections as Type 3 (Trout stream). Most tributaries to Savage River are classified as Type 2 (Trout feeder) in their headwaters and Type 3 (Trout stream) in their lower reaches, except that Crabtree Creek is classified as Type 4 (Sucker stream). Georges Creek is classified as Type 2 (Trout feeder) in the headwaters, Type 3 (Trout stream) in the upper reaches below the headwaters, and 2P (Trout feeder with observed pollution condition) in the lower reaches. The main stem of the North Branch Potomac River in this sub-reach is classified as 6P (Bass stream with observed pollution condition).

New Creek to Wills Creek (24.0 miles)

This entire 24-mile sub-reach is classified as 8P (Bullhead stream with observed pollution condition).

## APPENDIX VI. (Continued)

Wills Creek to South Branch (21.7 miles)

Wills Creek in Maryland has been classified as Type 6 (Bass stream) upstream and Type 6P (Bass stream with observed pollution condition) downstream. Jennings Run is classified as Type 3P (Trout stream with observed pollution condition). Braddock Run, while not reported, would probably be classified the same as Jennings Run. Evitts Creek has been assigned Type 5 (Bass feeder) classification. The North Branch in the sub-reach from Cumberland to its junction with the South Branch is classified as Type 8 (Bullhead stream).

## II. POTOMAC RIVER, SOUTH BRANCH TO CONOCOCHEAGUE CREEK

South Branch to Tonoloway Creek (47.6 miles)

This sub-reach of the Potomac River has been classified as Type 6 (Bass stream). Fifteen Mile Creek (confluence at River Mile 255.4) and Sideling Hill Creek have been classified as Type 5 (Bass feeder). Little Tonoloway Creek has been classified as Type 4 (Sucker stream).

Tonoloway Creek to Conococheague Creek (26.8 miles)

Tonoloway Creek in Maryland has been classified as Type 5P (Bass feeder with observed pollution condition) before the construction of waste treatment facilities at Hancock. It is assumed that the classification would now be Type 5, except perhaps immediately below the effluent outfall. The Potomac River in this sub-reach is classified as Type 6 (Bass stream). Licking Creek is classified as Type 6 (Bass stream). Little Conococheague Creek, which enters the Potomac River at River Mile 216.6, is classified as Type 4 (Sucker stream).

## APPENDIX VI. (Continued)

### III. POTOMAC RIVER, CONOCOCHEAGUE CREEK TO LITTLE FALLS

Conococheague Creek to Antietam Creek (30.5 miles)

Conococheague Creek in Maryland has been classified as Type 9 (Catfish stream). Rockdale Run, which enters Conococheague Creek at River Mile 17.0, is classified as Type 4 (Sucker stream). The Potomac River in this sub-reach is classified as Type 5 (Bass feeder). Marsh Run, which enters the Potomac River at River Mile 192.4, is classified as Type 4 (Sucker stream).

Antietam Creek to Monocacy River (26.7 miles)

Antietam Creek has been classified as Type 5 (Bass feeder). The upper reaches of the small tributaries of Antietam Creek near the Pennsylvania State line are classified as Type 4 (Sucker stream). The Potomac River between Antietam Creek and the Shenandoah River is classified as Type 6 (Bass stream). The Potomac River between the Shenandoah River and the Monocacy River is classified as Type 9 (Catfish stream). The West Branch of Catoctin Creek, which enters Catoctin Creek (Maryland) at River Mile 28.2, is classified as Type 2 (Trout feeder). The upper-third of Catoctin Creek (Maryland) is classified as Type 3 (Trout stream), the middle-third as Type 5 (Bass feeder), and the lower-third as Type 6 (Bass stream). Little Catoctin Creek, which enters Catoctin Creek at River Mile 17.0, is classified as Type 4 (Sucker stream). Tuscarora Creek, which enters the Potomac River at River Mile 155.7, is classified as Type 4 (Sucker stream).

Monocacy River to Little Falls (37.4 miles)

The Monocacy River has been classified as Type 6 (Catfish stream) except for a short reach of about three miles just below the Pennsylvania State line, which is classified as Type 5 (Bass feeder). The small tributaries of the Monocacy River to the west of the River are generally classified as Type 3 (Trout stream) in the headwaters, and as Type 5 (Bass feeder) downstream. The larger tributaries of the Monocacy River to the east of the River are generally classified as Type 4 (Sucker

APPENDIX VI. (Continued)

stream) in the headwaters, as Type 5 (Bass feeder) in the mid-reaches, and as Type 6 (Bass stream) in the lower reaches. The Potomac River in this sub-reach is classified as Type 9 (Catfish stream). Horsepen Branch, which enters the Potomac River at River Mile 137.9, is classified as Type 4 (Sucker stream). Seneca Creek is classified as Type 6 (Bass stream) in the lower reach, and its two major tributaries, Dry Seneca Creek and Great Seneca Creek, are classified as Type 4 (Sucker stream) in the headwaters, and as Type 5 (Bass feeder) downstream. Muddy Branch, which enters the Potomac River at River Mile 131.4, is classified as Type 4 (Sucker stream) in the upper half, and as Type 5 (Bass feeder) in the lower half. Watts Branch, which enters the Potomac River at River Mile 129.2, is classified as Type 4 (Sucker stream). Cabin John Creek is classified as Type 8 (Bullhead stream).

## APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Wills Creek | 21.7 | | | | |
| Hyndman, Pa. | | 1,124 | | None | 190 |
| Jennings Run | 4.4 | | | | |
| Frostburg, Md. | | | | None | |
| Appalachian Stone Corp. | 4.1 | Wash-Sand & Gravel | | Settling | |
| Manley Sand Corp. | 3.1 | Wash-Sand & Gravel | | Settling | |
| Braddock Run | 2.3 | | | | |
| La Vale, Md. | | 4,031 | | None | 680 |
| Ridgeley, W. Va. | 21.5 | 1,000 | | None | 170 |
| Cumberland, Md. | 18.2 | 33,000 | 5,000,000[e] | Primary | |
| Evitts Creek | 17.5 | | | | |
| Growdenvale, Md. | 2.0 | 65 | | Primary | 10 |
| Pittsburgh Plate Glass Co. | 11.3 | Industrial | 2,300,000 | Lagoon | |
| | 11.1 | 1,200 | 25,000 | Primary | 200 |
| POTOMAC RIVER MAIN STEM | | | | | |
| South Branch Potomac River (W. Va.) | 285.1 | Various | | | |
| Paw Paw, W. Va. | 276.8 | 750 | 50,000 | None[f] | 110 |

---

e. This includes wastes from several industries.
f. Lagoon under construction. Loading will be 15 lbs. B.O.D. (5-day) per day.

## APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Warm Springs Run (W. Va.) | 238.3 | | | | |
| Berkeley Springs, W. Va. | 7.0 | 700 | | None | 120 |
| Pennsylvania Glass Sand Co. | 4.0 | 225 | 3,500 | None | 40 |
| | | Sand Washing | 180,000 | Settling | |
| Tonoloway Creek | 237.5 | | | | |
| Hancock, Md. | 0.8 | 2,000 | 150,000 | Lagoon | 50 |
| Back Creek (W. Va.) | 225.9 | 500 | | | 85 |
| Conococheague Creek | 210.7 | | | | |
| Scotland Orphanage, Pa. | | 850 | 100,000 | Secondary | 140 |
| Dixon TB Hospital, Pa. | | 1,700 | 300,000 | Secondary | 240 |
| Chambersburg, Pa. | | 22,000 | 3,000,000 | Secondary | 3,700 |
| H. J. Heinz Co. | | Canning | 500,000 | Secondary | |
| Path Valley Esso | | Industrial | 25,000 | Secondary | |
| Mercersburg, Pa. | | 2,300 | 220,000 | Secondary | 390 |
| Lowengart & Co. | | Tannery | 220,000 | Primary | |
| Greencastle, Pa. | | 4,000 | 125,000 | Secondary | 680 |
| Greencastle Packing Co. | | Meat Packing | 12,000 | Secondary | |
| Williamsport, Md. | | | | | |
| W. D. Byron & Sons | 0.3 | Tannery | 300,000 | Screening,<br>Neutralization,<br>Aeration &<br>Settling | |
| Potomac Edison Co. | 210.6 | Boiler | 42,000 | | |
| | | Cooling | 72,000,000 | Settling | |
| Williamsport, Md. | 210.3 | 1,900 | 30,000 | Primary | 210 |

APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Falling Waters, W. Va. | 205.4 | | | | |
| E. I. DuPont de Nemours & Co. | 205.4 | 420 | 10,000 | Intermediate | 70 |
| | | Industrial | 500,000 | | |
| Opequon Creek (W. Va.) | 202.0 | | | | |
| Winchester, Va. | | | 2,500,000 | Secondary | |
| Middleway, W. Va. | | | No community system | | |
| Inwood, W. Va. | | | No community system | | |
| Musselman Canning Co. | | Industrial | 300,000 | Intermediate | |
| Leetown, W. Va. | | | No community system | | |
| Kearneysville, W. Va. | | | No community system | | |
| Martinsburg, W. Va. | | Industrial[g] | 750,000 | | |
| | | 12,000 | 2,500,000 | Secondary | 305 |
| Shepherdstown, W. Va. | 183.0 | 2,000 | 150,000 | None | 340 |
| Antietam Creek | | | | | |
| Waynesboro, Pa. | | 11,000 | 1,200,000 | Secondary | 1,900 |
| E. U. B. Orphanage, Pa. | | 350 | 21,000 | Secondary | 60 |
| Camp Ritchie (National Guard), Md. | | 1,000 | 50,000 | Secondary | 170 |
| Security, Md. | | | | | |
| Marquette Cement Co. | 26.8 | Cooling | 7,800,000 | | |
| Marsh Run | 26.4 | | | | |
| Fairchild Stratos Corp. | | Plating | 150,000 | | |
| | | Cooling | 50,000 | | |
| | | Sanitary | 30,000 | Secondary | |
| Municipal Electric Light Plant | 23.7 | Cooling | 33,000,000 | | |
| Hagerstown, Md. | 22.6 | 36,000 | 3,800,000 | Secondary | 6,100 |

---

[g] This total accounts for the industrial wastes of the following: National Fruit Co., Interwoven Co., Standard Lime & Stone Co., and Blair Lime Stone Co.

APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Antietam Creek (Continued) | | | | | |
| Unnamed Tributary | | | | | |
| Western Maryland Rail. Co. | | RR Car & Engine Cleaning | 150,000 | Settling & Oil Removal | |
| Funkstown, Md. | 21.4 | 970 | 75,000 | Lagoon | 25 |
| Breathedsville, Md. | | | | | |
| Maryland State Reformatory for Males | 12.4 | 1,250 | 450,000 | Secondary | 30 |
| Little Antietam (southern) | | | | | |
| Boonsboro, Md. | | 1,200 | 60,000 | Lagoon | 30 |
| Keedysville, Md. | 1.0 | 320 | 47,000 | None | 55 |
| Shenandoah River (Va.) | 171.5 | Various | | | |
| Brunswick, Md. | 165.2 | 3,700 | 250,000 | Primary | 410 |
| Baltimore and Ohio Railroad Yard | 165.3 | Cleaning | | Settling & Oil Removal | |
| Catoctin Creek | 162.4 | | | | |
| Myersville, Md. | 24.7 | 450 | 25,000 | Primary | 50 |
| Middletown, Md. | 15.4 | 1,100 | 60,000 | Primary | 120 |
| Catoctin Creek (Va.) | 159.8 | | | | |
| Purcellville, Va. | | 850 | 105,000 | Primary | 140 |
| J. Lynn Cornwell, Inc. | | Meat Packing | 110,000 | | |
| Lovettsville, Va. | | | 37,000 | None | |

APPENDIX V. (Continued)

| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Monocacy River | 153.5 | | | | |
| Gettysburg, Pa. | | 10,000 | 750,000 | Secondary | 1,700 |
| Littlestown, Pa. | | 2,800 | 160,000 | Secondary | 50 |
| Funkhouser Co. | | Inorganic | 108,000 | Lagoons | |
| Piney Creek | 45.3 | | | | |
| Taneytown, Md. | | 1,500 | 150,000 | Secondary | 40 |
| Toms Creek | 43.9 | | | | |
| Sabillasville, Md. | | | | | |
| Victor Cullen State Hospital | | 200 | 35,000 | Secondary | 5 |
| Emmitsburg, Md. | | 2,600 | 250,000 | Secondary | 65 |
| St. Mary's College | | 600 | 50,000 | Primary & Lagoon | 15 |
| Mt. St. Joseph's Academy | | 900 | 70,000 | Primary | 100 |
| Double Pipe Creek | 38.3 | | | | |
| Willow Farms Dairy | | Milk Processing | 40,000 | | |
| Westminister, Md. | | 8,000 | 750,000 | Secondary | 210 |
| George W. Magin Co. | | Steam Condensate | 20,000 | | |
| New Windsor, Md. | | 700 | 55,000 | Secondary | 20 |
| Union Bridge, Md. | | 800 | 65,000 | Lagoon | 20 |
| Hunting Creek | 31.6 | | | | |
| Thurmont, Md. | | 675 | 55,000 | Secondary | 20 |
| Howard Late & Co. | | Meat-Packing | 18,000 | Primary | |
| Catoctin Furnace, Md. | | | | | |
| Fraley's Meats | | Meat-Packing | 9,000 | Lagoon | |

# APPENDIX V. (Continued)

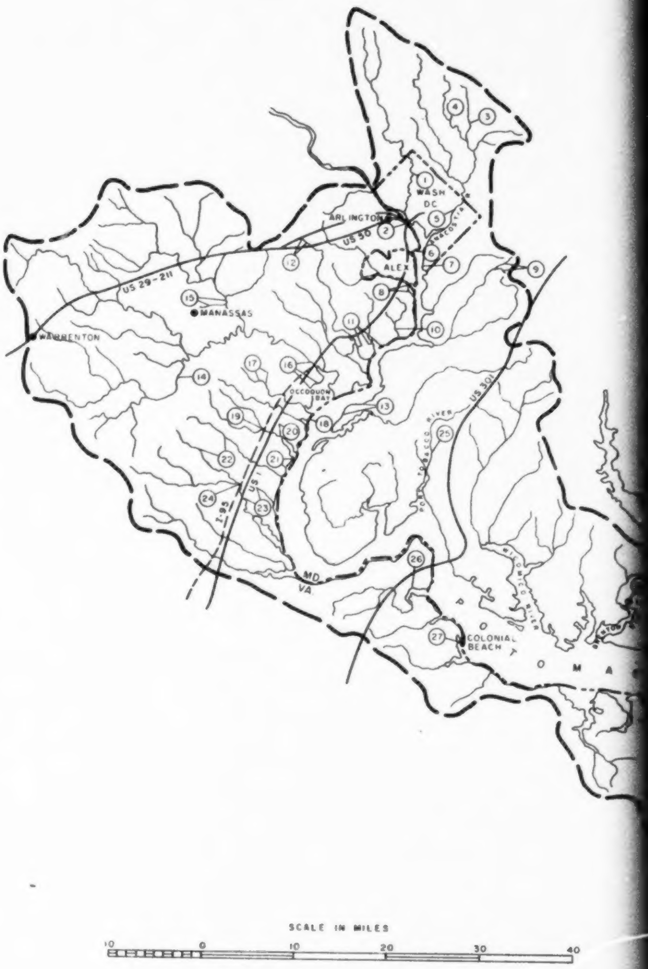
| Location of Municipality or Industry | River Miles | Population Served or Waste Type | Waste Discharge (gpd) | Type of Treatment | B.O.D. (5) Discharged (lbs/day) |
|---|---|---|---|---|---|
| Monocacy River (Continued) | | | | | |
| Detrick Creek | 20.1 | | | | |
| Ideal Farms Dairy | | Cooling | 4,000 | | |
| Fort Detrick | 19.7 | | 650,000 | Secondary | 15 |
| Carroll Creek | 18.8 | | | | |
| Everedy Co. | | Plating | 94,000 | Neutralization | |
| Jenkins Brothers | | Canning | | | |
| Corning Packaging Co. | | Cooling & Foam Plastic Packaging | | | |
| Frederick, Md. | 18.7 | 24,500 | 3,800,000 | Secondary[h] | 1,200 |
| Linganore Creek | 16.3 | | | | |
| Unionville, Md. | | | | | |
| Maryland Coop. Milk Producers | | Industrial | 2,000 | | |
| PEPCO Dickerson Generating Station, Md. | 152.1 | 81 | 1,215 | Secondary | 2 |
| | | Cooling | 355,077,000 | None | |
| Goose Creek (Va.) | 142.1 | | | | |
| Middlesburg, Va.[i] | | 3,000 | 240,000 | Secondary | 80 |
| Sugarland Creek (Va.) | 135.3 | | | | |
| Herndon, Va. | | 1,960 | 155,000 | Secondary | 50 |

---

h. This includes dairy, poultry, meat packing, and cannery wastes.
i. This includes Leesburg, Goose Creek Country Club, and Foxcroft School, Va.

**KEY:**

① D.C. WEST HEATING PLANT
② VA HEATING & SEWAGE DISPOSAL PLANT
③ MINERAL PIGMENTS CORP
④ U.S. NAVAL ORDNANCE LABORATORY
⑤ PEPCO BENNING GENERATING STATION
⑥ ARLINGTON COUNTY, VIRGINIA
⑦ D.C. NAVAL RESEARCH LABORATORY
  BLUE PLAINS SEWAGE TREATMENT PLANT
  PEPCO POTOMAC RIVER STATION
⑧ FAIRFAX COUNTY, SAN DIST #1, WESTGATE PLANT
⑨ ANDREWS AIR FORCE BASE PLANT #1
  ANDREWS AIR FORCE BASE PLANT #4
⑩ FAIRFAX COUNTY, LITTLE HUNTING CREEK PLANT
⑪ FAIRFAX COUNTY, DOGUE CREEK PLANT
  FORT BELVOIR (U.S. ARMY) PLANT #2
  FORT BELVOIR (U.S. ARMY) PLANT #1
⑫ FAIRFAX, VIRGINIA
  ~~VIENNA, VIRGINIA (2 PLANTS)~~
⑬ POTOMAC HEIGHTS, MARYLAND
  INDIAN HEAD, MARYLAND
  U.S. NAVAL PROPELLANT PLANT-HOUSING, STORAGE & INDUSTRIAL AREA
⑭ CAMP UPSHUR (U.S. MARINE CORPS)
⑮ MANASSAS, VIRGINIA
  MANASSAS REGIONAL HIGH SCHOOL
⑯ OCCOQUAN, VA (WOODBRIDGE S.D. PLANT)
  WOODBRIDGE S.D. MARUMSCO PLANT
  WOODBRIDGE S.D. LYNWOOD-FEATHERSTONE PLANT
⑰ M.G. GARBER TRAILER PARK
  GARFIELD HIGH SCHOOL
⑱ FREESTONE POINT, VIRGINIA
⑲ DUMFRIES TRIANGLE (2 PLANTS)
  DUMFRIES SCHOOL
⑳ MELROSE GARDENS SUBDIVISION
㉑ QUANTICO MARINE CORPS RESERVATION
㉒ BROWN FIELD OF U.S.M.C. (SUMMER)
  RIFLE RANGE OF U.S.M.C.
㉓ MIDWAY ISLAND HOUSING OF U.S.M.C.
  CAMP BARRETT OF U.S.M.C.
㉔ AQUIA MOBILE PARK
㉕ LA PLATA, MARYLAND
㉖ U.S. NAVAL WEAPONS LABORATORY AT DALGREN, VIRGINIA
㉗ COLONIAL BEACH, VIRGINIA
㉘ LEONARDTOWN, MARYLAND
㉙ ST MARY'S CITY, MARYLAND
  PINEY POINT, MARYLAND (SUMMER)
㉚ ST MARY'S JR COLLEGE
㉛ NAVAL AIR NAVIGATION & ELECTRONICS PROJECT

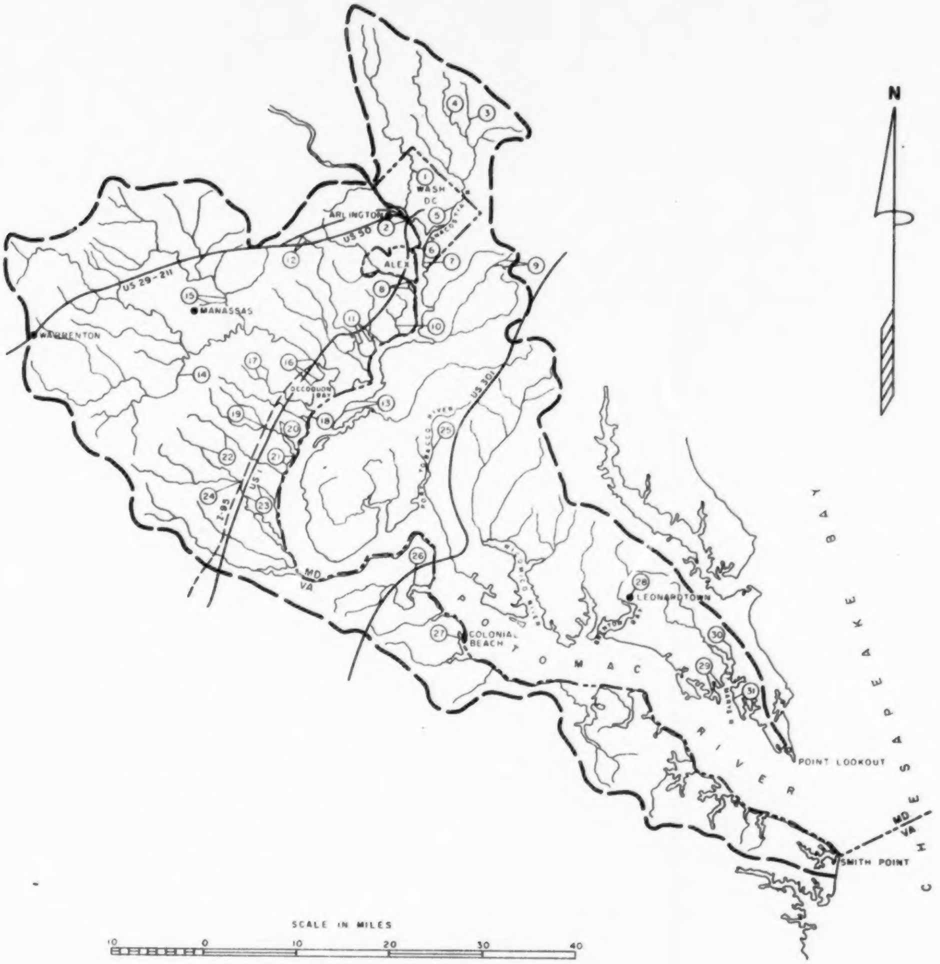


WATER
POTOMAC RIV

**MUN. & INDUS.**

POTOMAC

U.S. DEPARTMENT OF H
PUBLIC
CHESAPEAKE BAY-SUB
REGION III



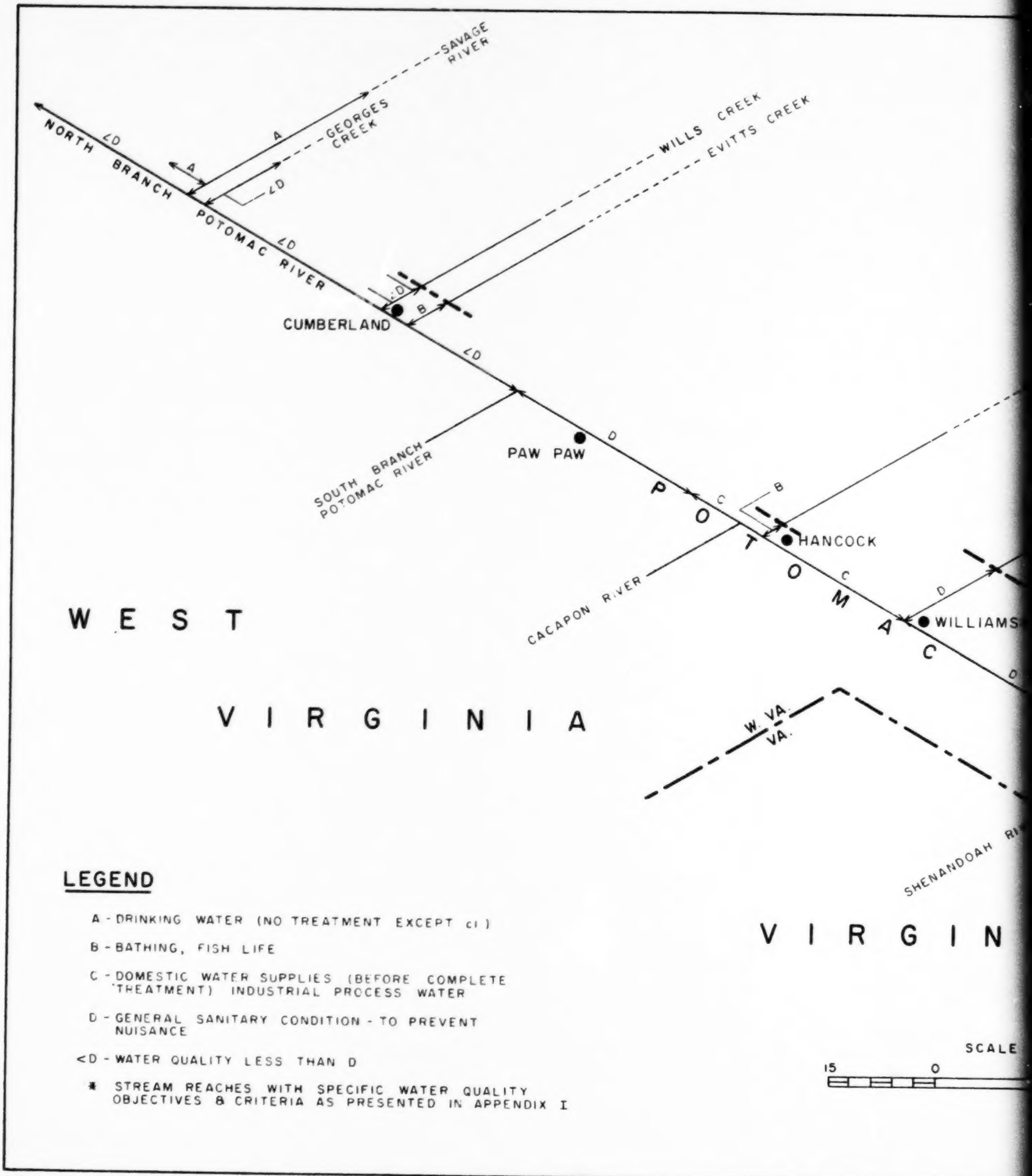
WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

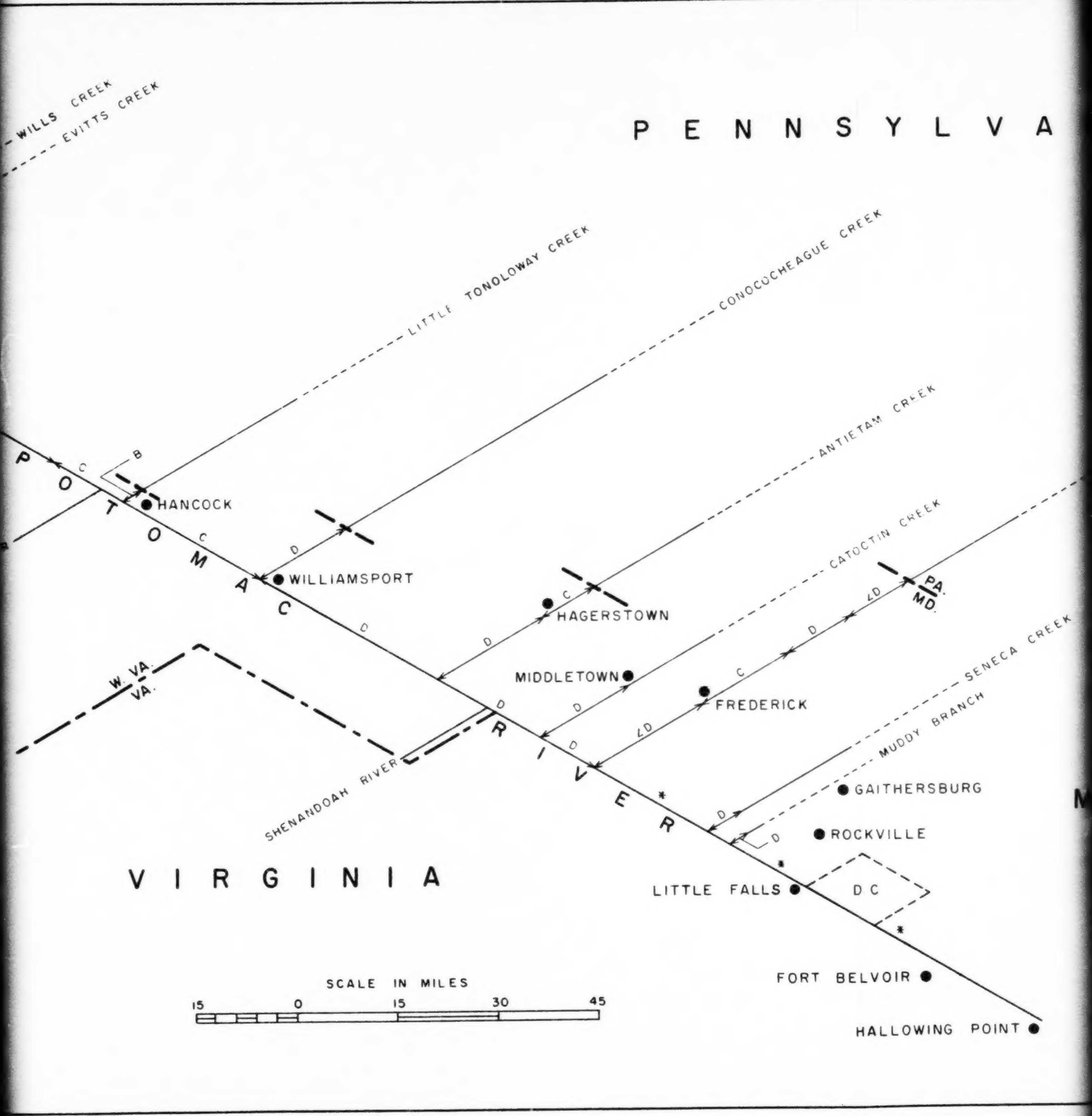
## MUN. & INDUS. WASTE DISCHARGES

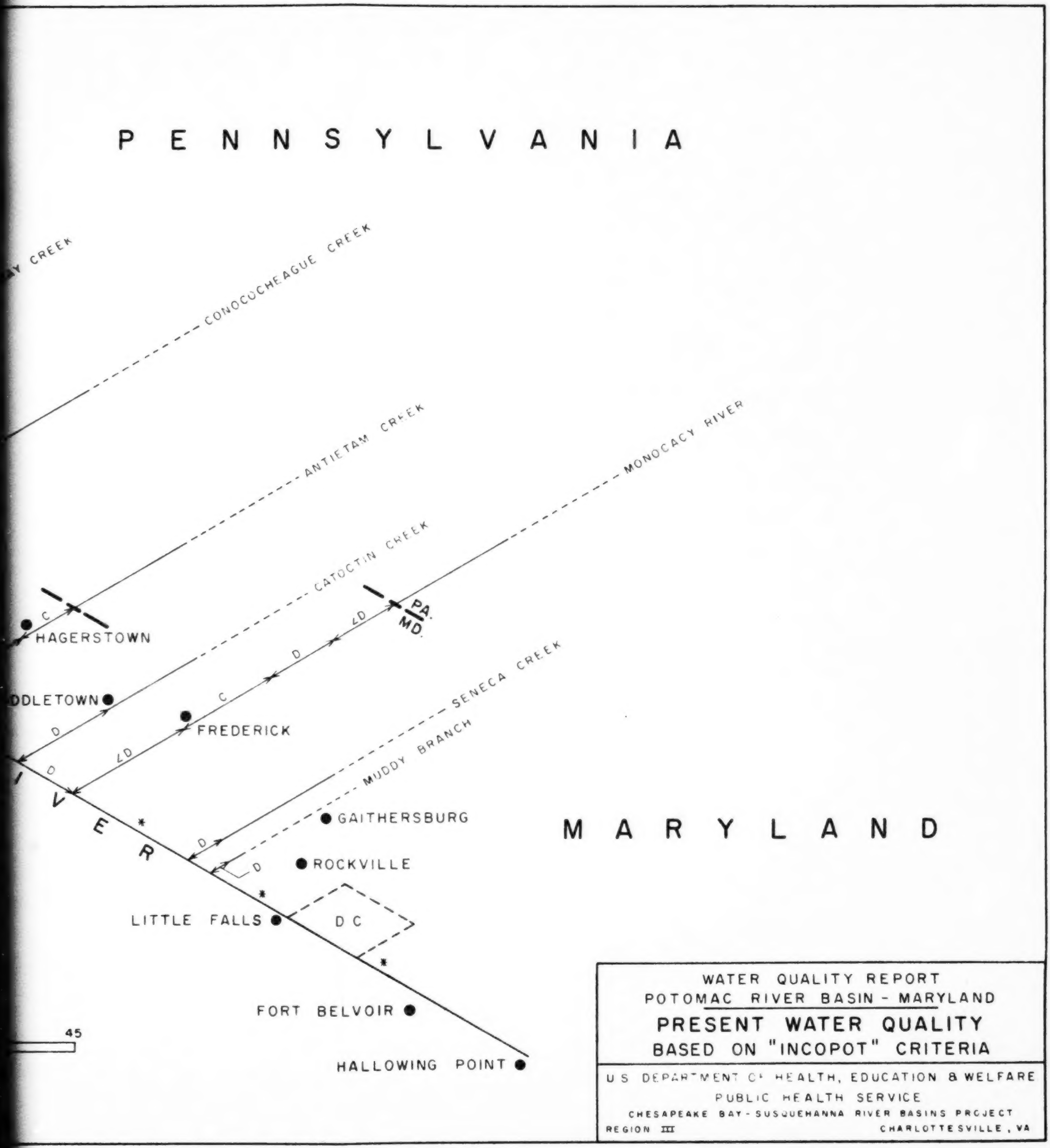
POTOMAC RIVER ESTUARY

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY-SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 15


SAVAGE RIVER
GEORGES CREEK
WILLS CREEK
EVITTS CREEK
NORTH BRANCH POTOMAC RIVER
A
<D
D
B
C
CUMBERLAND
SOUTH BRANCH POTOMAC RIVER
PAW PAW
POTOMAC
HANCOCK
CACAPON RIVER
WILLIAMS
WEST VIRGINIA
W. VA.
VA.
SHENANDOAH RI
VIRGIN
SCALE
15
0
LEGEND
A - DRINKING WATER (NO TREATMENT EXCEPT cl)
B - BATHING, FISH LIFE
C - DOMESTIC WATER SUPPLIES (BEFORE COMPLETE TREATMENT) INDUSTRIAL PROCESS WATER
D - GENERAL SANITARY CONDITION - TO PREVENT NUISANCE
<D - WATER QUALITY LESS THAN D
* STREAM REACHES WITH SPECIFIC WATER QUALITY OBJECTIVES & CRITERIA AS PRESENTED IN APPENDIX I


WILLS CREEK
EVITTS CREEK
PENNSYLVA
LITTLE TONOLOWAY CREEK
CONOCOCHEAGUE CREEK
ANTIETAM CREEK
CATOCTIN CREEK
SENECA CREEK
MUDDY BRANCH
B
C
D
POTOMAC
RIVER
HANCOCK
WILLIAMSPORT
HAGERSTOWN
MIDDLETOWN
FREDERICK
PA.
MD.
W. VA.
VA.
SHENANDOAH RIVER
GAITHERSBURG
ROCKVILLE
LITTLE FALLS
D C
M
VIRGINIA
FORT BELVOIR
HALLOWING POINT
SCALE IN MILES
15
0
15
30
45

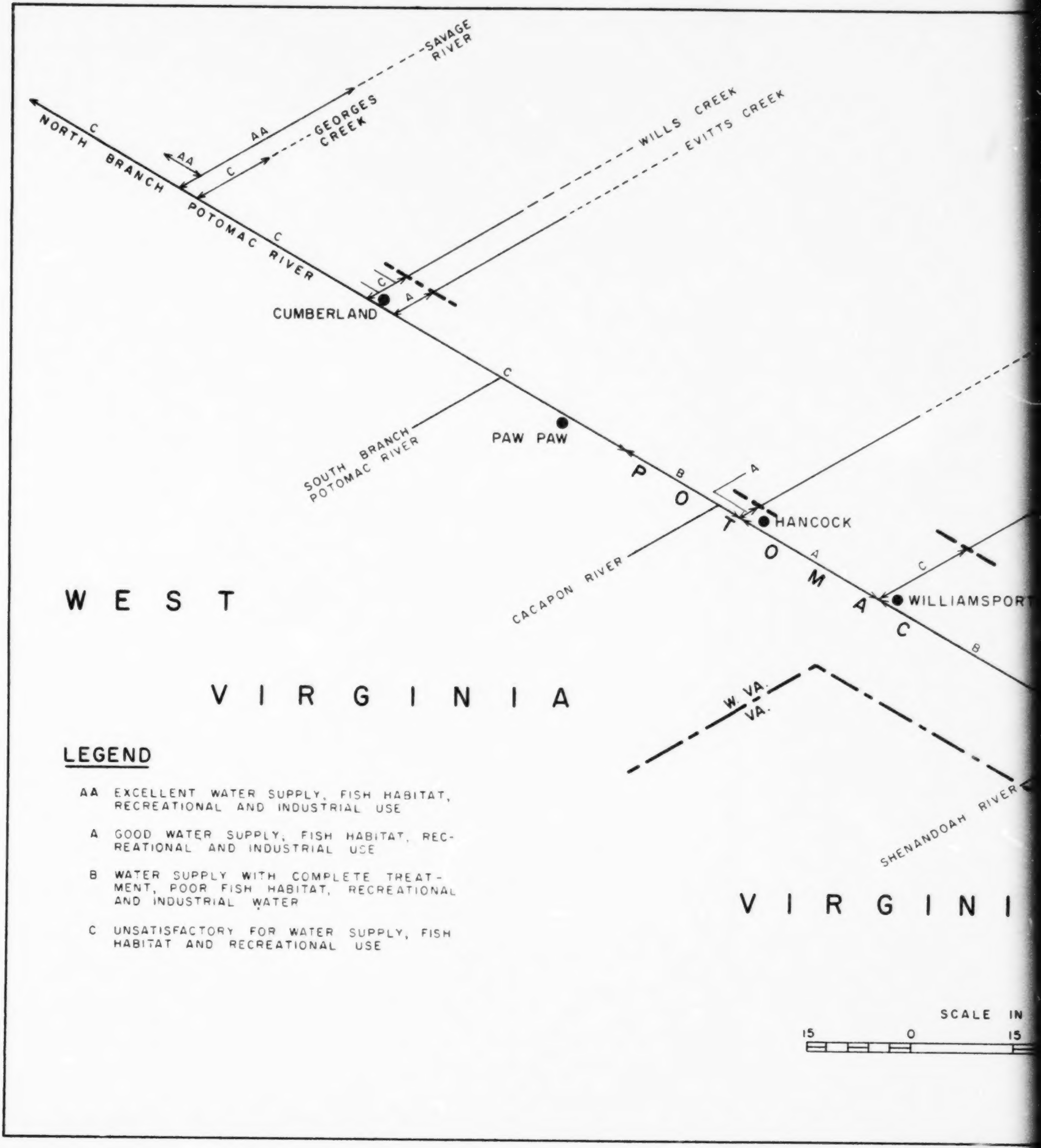


WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

**PRESENT WATER QUALITY**
**BASED ON "INCOPOT" CRITERIA**

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA

FIGURE 16



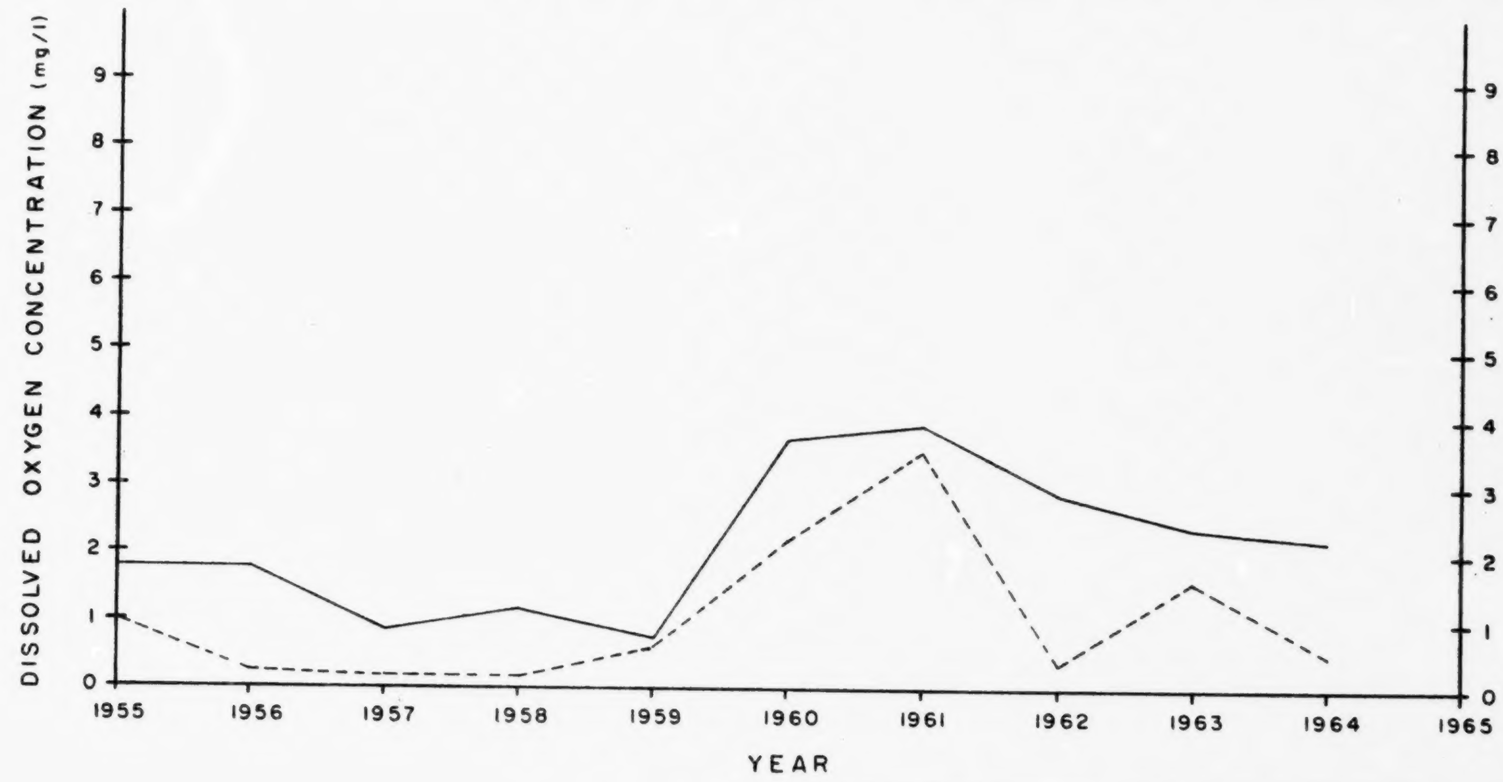
**LEGEND**

AA EXCELLENT WATER SUPPLY, FISH HABITAT, RECREATIONAL AND INDUSTRIAL USE

A GOOD WATER SUPPLY, FISH HABITAT, RECREATIONAL AND INDUSTRIAL USE

B WATER SUPPLY WITH COMPLETE TREATMENT, POOR FISH HABITAT, RECREATIONAL AND INDUSTRIAL WATER

C UNSATISFACTORY FOR WATER SUPPLY, FISH HABITAT AND RECREATIONAL USE

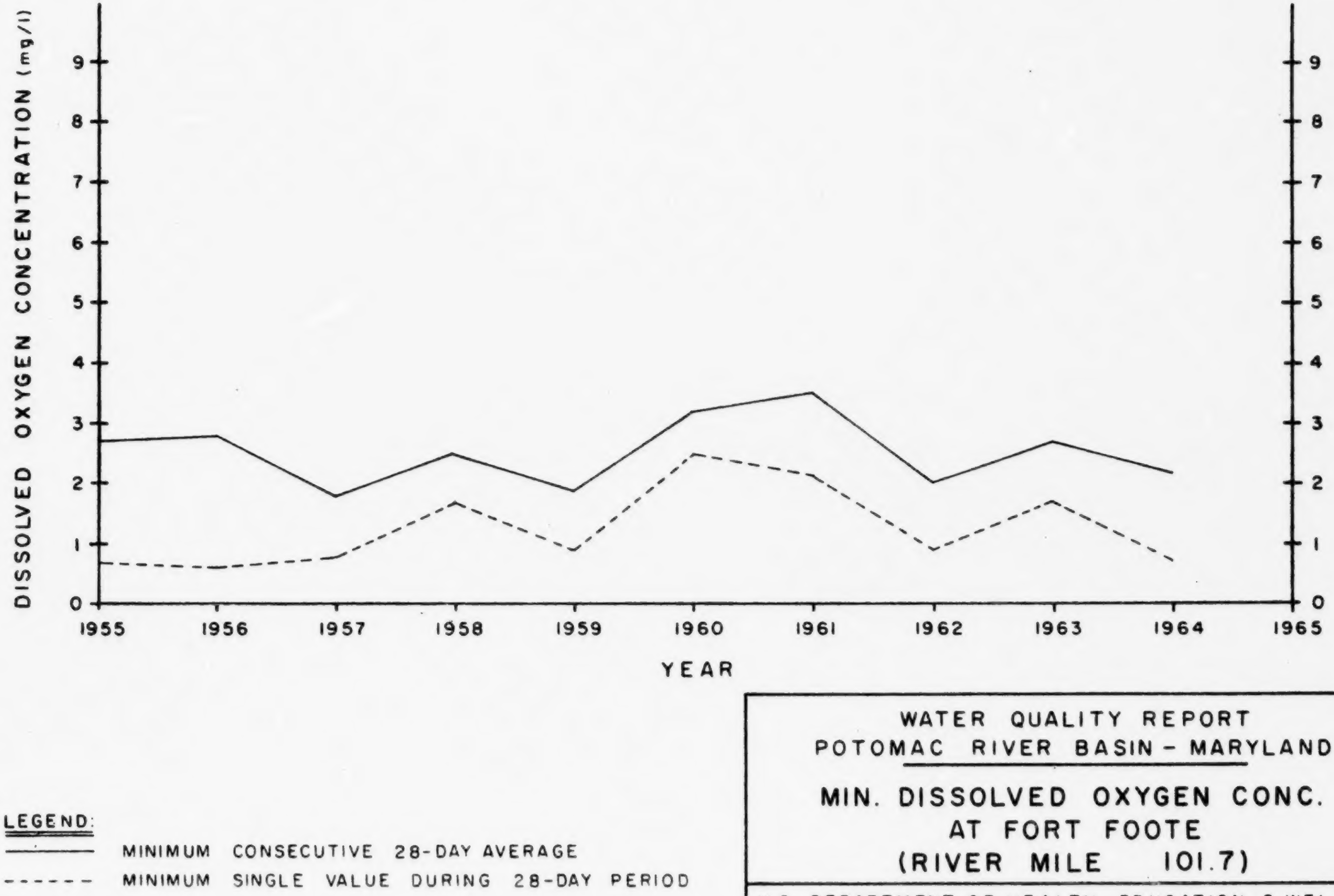


WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

MIN. DISSOLVED OXYGEN CONC.
BELOW D.C. OUTFALL
(RIVER MILE 105.1)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 6

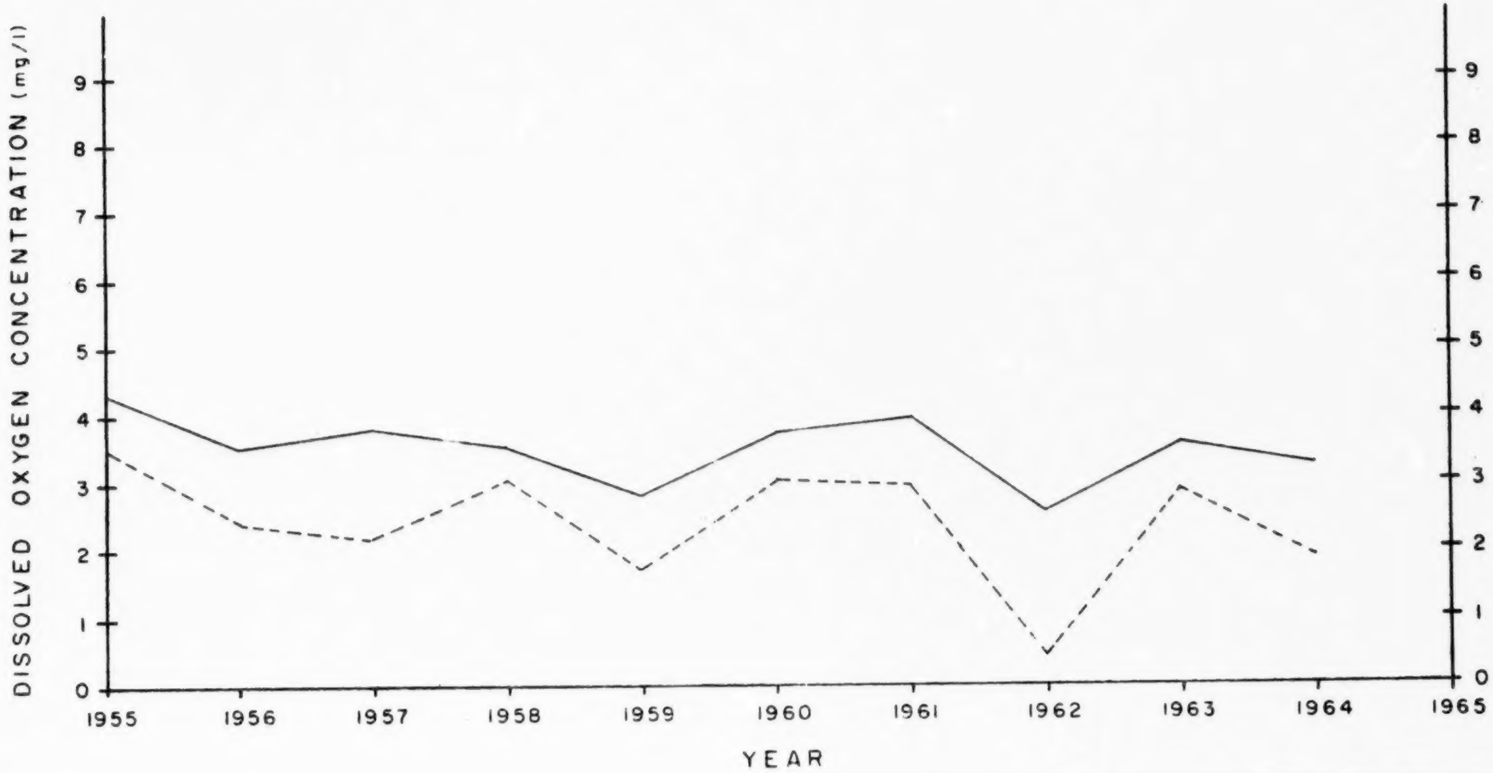


WATER QUALITY REPORT
POTOMAC RIVER BASIN – MARYLAND

**MIN. DISSOLVED OXYGEN CONC.**
**AT FORT FOOTE**
**(RIVER MILE 101.7)**

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 7

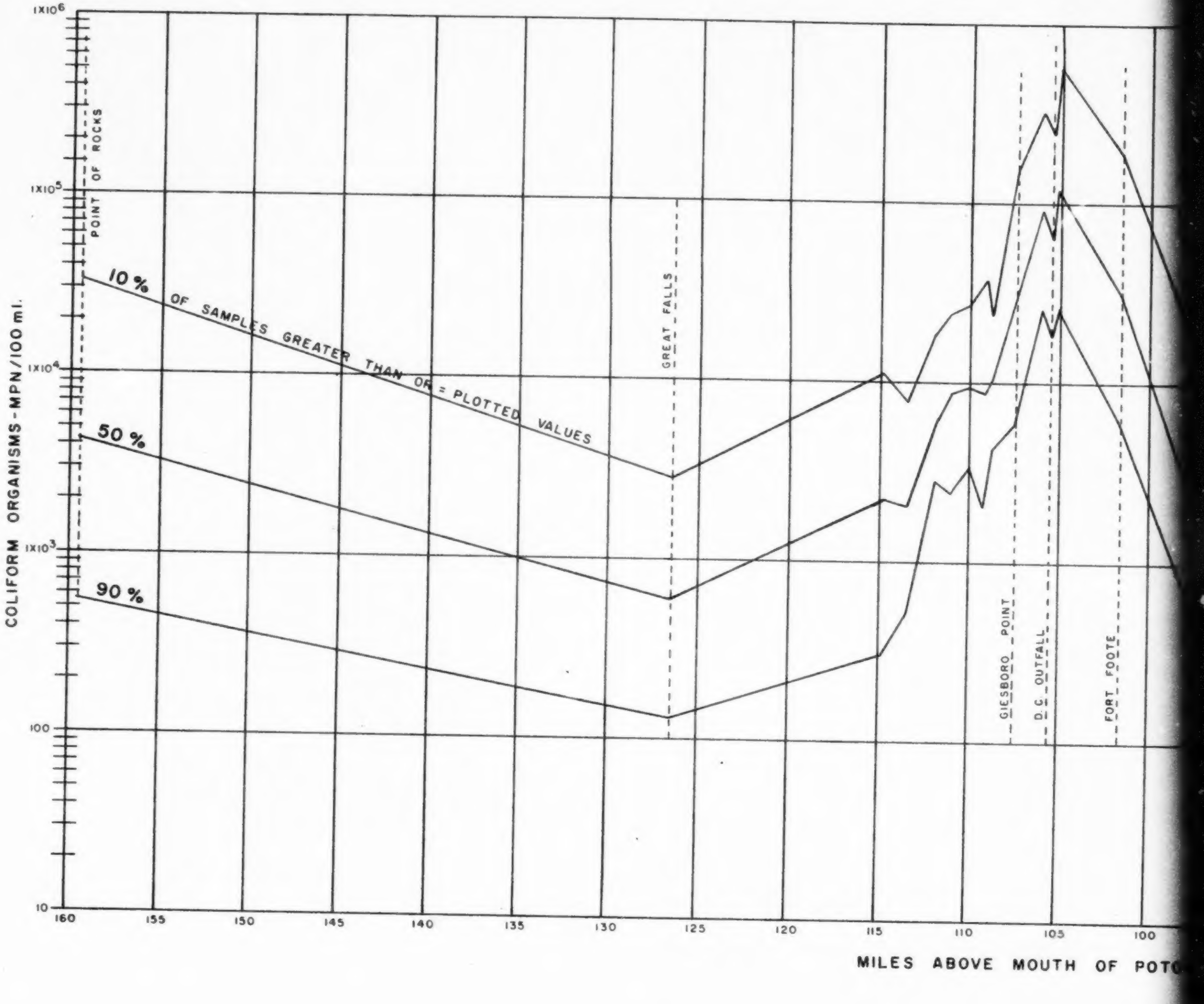


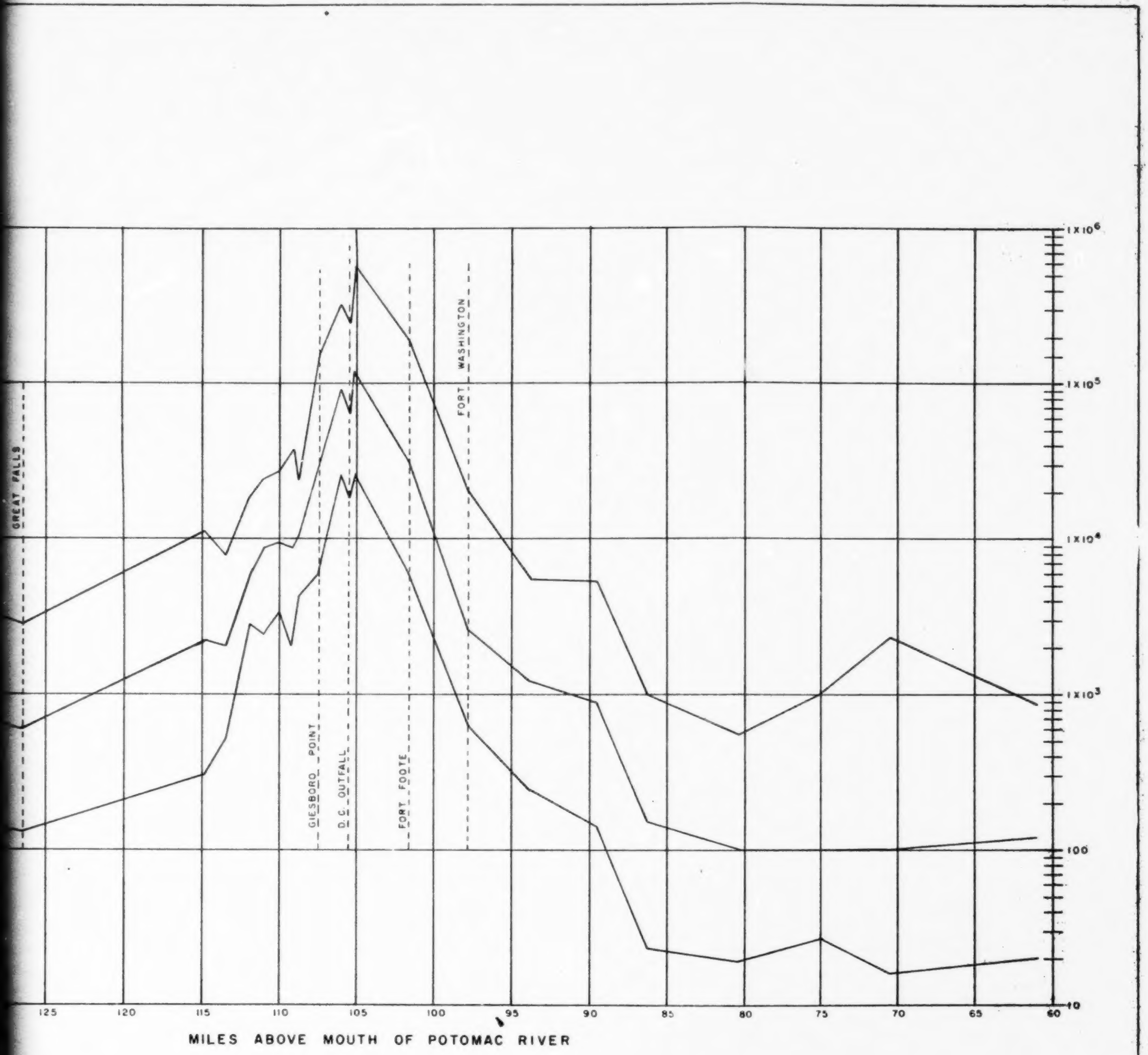
WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

MIN. DISSOLVED OXYGEN CONC.
AT FORT WASHINGTON
(RIVER MILE 97.8)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 8


COLIFORM ORGANISMS - MPN/100 ml.
1X10⁶
1X10⁵
1X10⁴
1X10³
100
10
10 % OF SAMPLES GREATER THAN OR = PLOTTED VALUES
50 %
90 %
POINT OF ROCKS
GREAT FALLS
GIESBORO POINT
D.C. OUTFALL
FORT FOOTE
160
155
150
145
140
135
130
125
120
115
110
105
100
MILES ABOVE MOUTH OF POTO

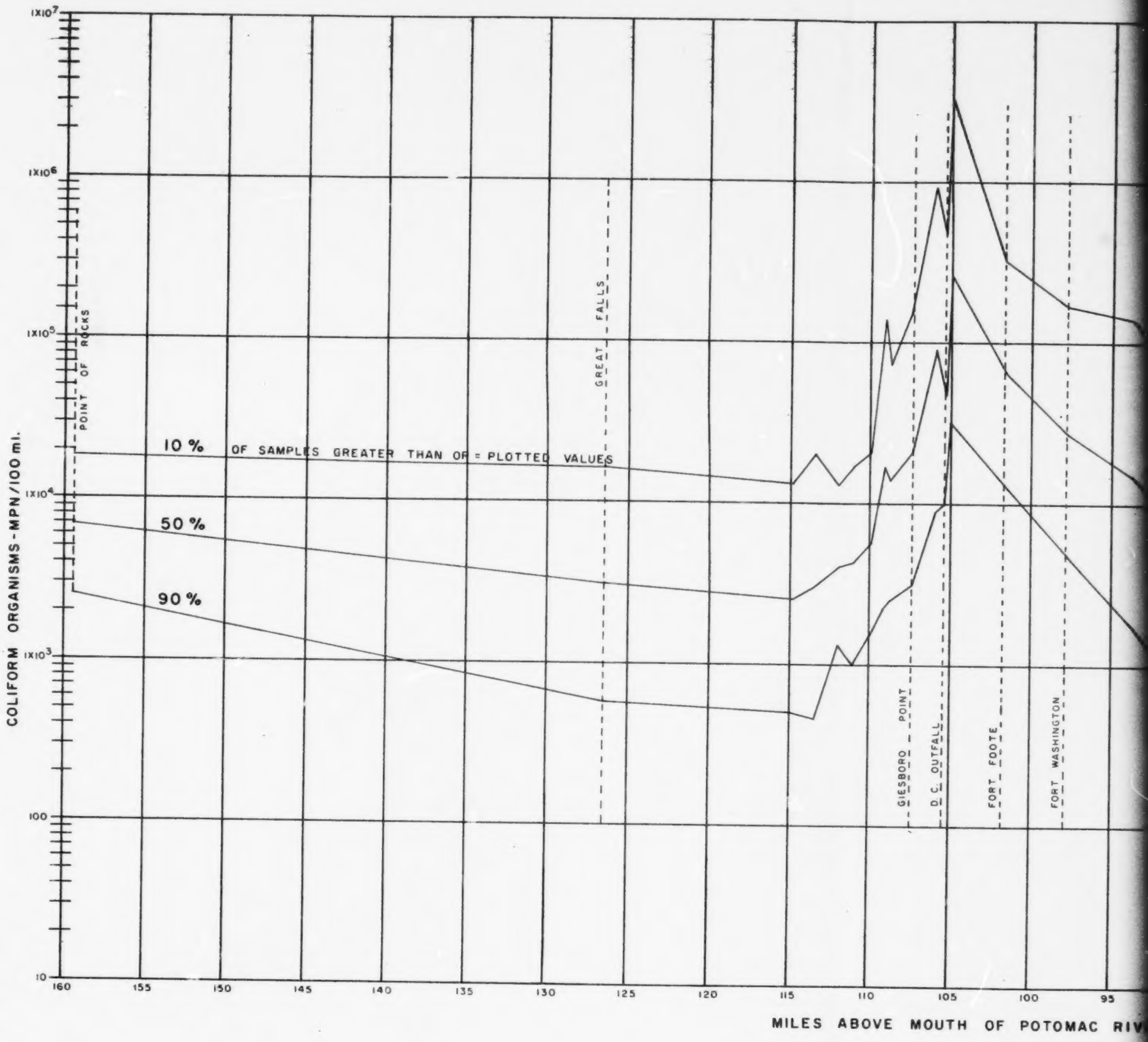


WATER QUALITY REPORT
POTOMAC RIVER BASIN - MARYLAND

POTOMAC ESTUARY-COLIFORM CONC.
JUNE-NOV, 1960-1964

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
CHESAPEAKE BAY-SUSQUEHANNA RIVER BASINS PROJECT
REGION III CHARLOTTESVILLE, VA.

FIGURE 9


COLIFORM ORGANISMS - MPN/100 ml.
1X10$^7$
1X10$^6$
1X10$^5$
1X10$^4$
1X10$^3$
100
10
160
155
150
145
140
135
130
125
120
115
110
105
100
95
POINT OF ROCKS
GREAT FALLS
GIESBORO POINT
D.C. OUTFALL
FORT FOOTE
FORT WASHINGTON
10 %
OF SAMPLES GREATER THAN OR = PLOTTED VALUES
50 %
90 %
MILES ABOVE MOUTH OF POTOMAC RIV